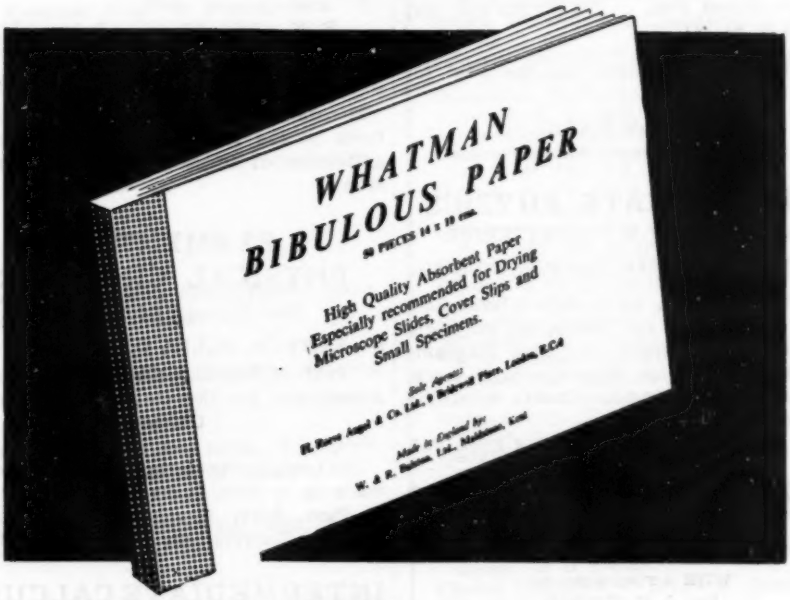
REGD. No. M. 2799

Upper Third

Current Science

Vol. 27, No. 6 JUNE 1958 Pages 195-230

Now in Booklets



Whatman Bibulous Paper

A simple aid for microscopy . . . an essential one in all laboratories, Whatman Bibulous Paper can now be bought in a most convenient form for drying microscope slides, cover slips etc. Booklets containing 50 perforated "tear-off" sheets are available from your usual Whatman stockist.

H. REEVE ANGEL & CO. LTD
9 BRIDEWELL PLACE, LONDON, EC4
also at **52 Duane Street, New York 7**

sole distributors of

WHATMAN FILTER PAPERS

Manufacturers W. & R. Balston Ltd

Current Science

Vol. XXVII] JUNE 1958 [No. 6

CONTENTS

Letters to the Editor

HINDUSTAN ANTIBIOTICS (PRIVATE) LTD.

(GOVERNMENT OF INDIA UNDERTAKING)

PIMPRI (NEAR POONA)

EMPLOYMENT NOTICE No. 5/58

APPLICATIONS in the prescribed form are invited on or before 26th July, 1958 for the following posts from persons with minimum qualifications mentioned against each:

(1) **Senior Scientific Officer - Grade 1** Organic Chemistry Section (1 post).

Scale: Rs. 600-40-1000-50/2-1150.

Qualifications: Ph.D. in Organic Chemistry with five years research experience and must be capable of organizing and carrying out research work on isolation, purification and chemical characterisation of antibiotics and mould metabolites.

(2) **Junior Scientific Officer - Mycology:** (1 post)

Scale: Rs. 275-25-500-EB-30-590.

Qualifications: Doctorate in Science (Mycology) or M.Sc. in Mycology with adequate research experience and knowledge of moulds with reference to their identity, physiology and handling for antibiotic production.

(3) **Junior Scientific Officer - Microbiology:** (1 post)

Scale: Rs. 275-25-500-EB-30-590.

Qualifications: Doctorate in Science (Microbiology) or M.Sc. in Microbiology with adequate research experience and knowledge of microbiological assay methods for antibiotics and vitamins.

Desirable: Experience in handling tissue cultures and embryonated eggs in virus work.

(4) **Technical Assistant - Mycology:** (1 post)

Scale: Rs. 160-10-330

Qualifications: B.Sc. (Hons.) or M.Sc. with Mycology or plant pathology as special subject. Knowledge of fungi groups and handling them in research work on antibiotics.

(5) **Assistant Librarian:** (1 post)

Scale: Rs. 160-10-330.

Qualifications: A degree in Science and a Diploma or Degree in Library Science from a recognised institution preferably with knowledge of one European Language and experience of one or two years in a technical library.

(6) **Junior Technical Assistants - Mycology:** (2 posts)

Scale: Rs. 100-5-120-EB-8-200-10/2-220.

Qualifications: B.Sc. in Botany or Agriculture preferably with knowledge of preparing and maintaining cultures.

Age Limit: For the posts (1) to (5) 35 years and for the last post 30 years on 1-8-1958 relaxable in case of exceptionally well qualified and experienced candidates and others belonging to scheduled caste/tribes.

Prescribed application forms are available with the Accounts Officer on payment of Re. 1/- by crossed Indian postal order drawn in favour of **Hindustan Antibiotics (Private) Limited,** Pimpri, payable at Penicillin Factory Post Office accompanied by a self-addressed adequately stamped envelope.

S. T. RAJA
Managing Director

STUDY OF COSMIC RAYS WITH EARTH SATELLITES*

TILL last century science had but two sources from which it could obtain information on outer space, stars, nebulæ and planets. The first source was light radiated by heavenly bodies, and the second was meteorites. They were the only heralds of outer space known to science, that came to Earth. Early in our century, scientists discovered that an endless stream of invisible and intangible rays was pouring down on the Earth from cosmic space, and they were called cosmic rays. It was established that these rays were fluxes of electrically-charged particles possessing very high energy. Later it was found that the rays discovered are not strictly speaking cosmic rays, but arise in the Earth's atmosphere under the action of particles which have really come from the interior of outer space and were called primary cosmic rays. Since the interaction of primary rays and atmospheric matter takes place at very great altitudes, scientists had to confine themselves for a long time to the study of secondary rays. These studies resulted in highly important discoveries in atomic physics.

The nature of the primary cosmic rays, their composition, that is the atomic particles of which they are composed, how they have been accelerated to tremendous energies, and, finally, where they originate, are of enormous interest for contemporary physics and astronomy. When the answer to these and many other questions relating to the nature of cosmic rays has been found, science will be able to throw light on a great many important problems of natural science required for an understanding of the processes taking place on the surface of stars and phenomena in interstellar space.

Study of the primary cosmic rays helps to solve too, a number of geophysical problems, such as the investigation of structure of the outer parts of our planet's magnetic field which are inaccessible to us.

However, to study the primary cosmic rays, experiments have to be conducted in the upper atmosphere. Until recently, these experiments were conducted by taking up recording instruments in balloons or rockets, but the achievements of Soviet science and engineering have made it possible to use an incomparably better means for the purpose, namely, artificial Earth satellites.

The first study of cosmic rays under such conditions was made on Sputnik-2. Two particle counters installed on the Sputnik made it possible to measure the full flux of cosmic rays at various altitudes above the Earth and over different areas of our planet.

The main purpose of these experiments was to determine how the streams of rays differ from one another in different latitudes and how the stream changes in time, in other words, to study the so-called variations of cosmic-radiation intensity.

A study of the variations is very important for understanding the nature of these rays and flux of particles emitted by the Sun, streams, which serve as the original cause of magnetic storms on the Earth.

It should be mentioned that fluctuations in the number of particles in the flux are found also on the Earth's surface, but these are variations of secondary radiation, very often depending not on the changes in the stream of primary particles, but on meteorological conditions, that is, how dense the atmosphere is at a particular moment and hence also how many atoms happened to be in the way of the primary rays. Besides, primary particles possessing low energy (it is their number which is subject to the greatest fluctuations) produces practically no "offspring", that is, secondary rays which reach the Earth's surface.

What new data on cosmic rays have been obtained by means of the Sputnik?

It has been established that between the altitude of the order of 200 kilometres (Sputnik-2's lowest altitude above the Earth) and the altitude of 700 kilometres the intensity of the stream of primary cosmic particles increases roughly 40%, while measurements made earlier by means of balloons and rockets showed that from an altitude of 40 kilometres and higher the intensity remains approximately constant.

Is there any contradiction here or not?

The increased number of particles at high altitudes can be thoroughly explained. There are two reasons for it. The stream of cosmic rays comes to the Earth uniformly from all around. However, since particles which possess even the highest energies cannot penetrate the Earth, measurements near the surface

* By L. Kurnosova and M. Fradkin of the Institute of Physical and Mathematical Sciences, U.S.S.R.

of the planet register only the rays which come from above. As the measuring instrument is taken up higher and higher, it leaves so to speak the globe's shadow, registering an ever larger part of the stream. Obviously, at a very considerable distance from the Earth, it will record a stream approximately twice as intense as on the surface. At an altitude of 700 kilometres 15% more particles pass through the instrument as a result of this phenomenon.

The remaining some 25% of the increase are due to the fact that the higher the altitude the lesser the Earth's magnetic field.

Charged particles, as we know, get deflected in their path in the presence of a magnetic field and the deflection is more when the energy of the particle is low and increases with the intensity of the magnetic field. In this sense the Earth's magnetic field can be compared to an armour. Particles possessing low energy are almost immediately thrown aside, and particles possessing higher energy penetrate deeper into it. Obviously the higher the instrument is taken up, the more particles should it register.

As a result of the experiments conducted on Sputnik-2 data were obtained on the distribution of particle flux above the Earth, that is, how the intensity of their flux depends on the latitude and longitude. This distribution too is the result of the interaction of the particles with the Earth's magnetic field. The field tends to deflect the incident particles in the direction of its poles. The existence of this phenomenon was obvious from theoretical reasons, and were corroborated experimentally.

The Sputnik, however, enabled us to get a somewhat different picture. Its counters showed that the particles are distributed by the magnetic field differently from what had been imagined earlier, and we may draw the conclusion that the Earth's magnetic field is responsible for it, as the structure of its upper regions is different from the way it was presented by the theory based on ground measurements.

The experiments on the distribution of the intensity of the cosmic rays over the whole globe conducted on Sputnik-2 are but the beginning of extensive studies of the structure of the Earth's magnetic field. Many careful measurements with the aid of sputniks will be required before the accumulated data permit us to make definite and reliable scientific deductions.

One of the assignments of the equipment on Sputnik-3 is to continue the study of the intensity of cosmic rays.

It was stated in the announcement on the launching of Sputnik-3 that it is equipped also with the instruments for registering the high-energy photons and heavy nuclei.

What is the purpose of these measurements?

Scientists assume that the Sun, in addition to radiating intensive corpuscular streams and cosmic rays, from time to time emits waves akin to visible light but much shorter, or, as they say, hard electromagnetic radiation, also called high-energy photons or gamma quanta.

High-energy photons, like primary cosmic rays, do not penetrate the atmosphere all the way down to the surface of our planet, and scientists using ground equipment can therefore neither confirm nor deny this assumption with full assurance. Balloons and rockets are of no substantial help in solving this problem; it can be cleared up only by means of an artificial satellite.

Today it is evidently premature to say what the acceptance or rejection of this hypothesis will mean to science, but at any rate our concepts of the Sun and its activity will become more complete. If it is found that our luminary radiates high energy photons, a very alluring prospect may open up to astronomy, the prospect of studying heavenly bodies not only in the rays of visible light and with the aid of the radio waves recently "mastered" by astronomers, but also of using high-energy photons for their purposes.

Sputnik-3 will study still another problem relating to the physics of cosmic rays, namely, it will register the presence of heavy atomic nuclei in these rays.

It is very important for science, chiefly for astrophysics, to know what atomic nuclei go to compose the primary cosmic rays and the sort of nuclei they contain. Data on this could tell us a great deal about the origin of cosmic rays.

Only by getting the proper instrument up to a considerable altitude will we be able to get an answer to this question. We have already mentioned that on the whole all primary rays are absorbed in the upper layers of the atmosphere. It may be added that the heavier the nucleus the greater the probability of its being absorbed, and the shorter the path it travels in the atmosphere, and, hence, the higher must be the instrument to make it possible to register heavy nuclei.

For this purpose up to now science has had a more or less clear idea of the number of light nuclei which are a component part of cosmic streams. The "variety" of nuclei has been ascertained: it makes up roughly a quarter of Mendeleyev's table of elements. So far

we have no information on the number of the heavier nuclei, but the studies by Sputnik-3 will enable us to throw light on this important problem too.

The launching of the third artificial Earth's satellite equipped with instruments to conduct all-round studies of cosmic space will further the progress made by means of the first sputniks and will provide science with many new data.

GEOCHEMICAL SURVEY TECHNIQUES

GEOCHEMICAL methods of mineral exploration are based on the premise that diagnostic disturbances in the normal distribution pattern of chemical elements may exist in accessible material in the vicinity of concealed ore deposits. Such geochemical anomalies result from the natural dispersion of elements from the site of the parent deposit and are commonly sought by the systematic sampling and analysis of rock, soil, vegetation, stream water and stream alluvium.

Geochemical dispersion patterns are subdivided into two genetic categories, namely, primary dispersions formed in depth at the time of mineralization, and secondary dispersions, which are usually formed in the zone of weathering. Primary dispersion patterns may occur as regional variations in the trace element content of rocks and minerals, associated with metallogenic provinces, aureoles of impregnation in the wall-rocks surrounding individual deposits, or 'leakage' dispersions of trace metals in the channel-ways followed by mineralizing solutions. In all cases, the primary dispersion is genetically related to the ore-forming processes. The interpretation of the geochemical anomalies in terms of the location of possible associated deposits is often difficult and is dependent on the understanding of the local geology. Secondary dispersions, on the other hand, are usually associated with the weathering cycle, and although the dispersion processes are complex, considerable progress has been made in the development and application of techniques having a proved practical value in prospecting. This is particularly true of geochemical soil surveys in areas of residual overburden, where the methods have been successfully used for detecting the presence of sub-outcropping deposits of copper, nickel, arsenic, gold, antimony, chromium, tin, tungsten, molybdenum and other metals.

At times, positive results have been obtained where copper, lead and zinc mineralizations have been concealed by transported glacial cover up to some tens of feet thick. Here, the metals have had the opportunity of migrating upwards into the overlying material by diffusion and other processes, including the growth of vegetation which has extracted the ore metals as part of its nutrient uptake. Although the systematic analysis of the plants themselves has been employed on occasions, it is normally found more practicable to sample the underlying soil wherein metal has accumulated over generations, in the biogeochemical cycle. Geochemical soil and vegetation anomalies are usually restricted to the immediate vicinity of the parent mineral deposit, but abnormal concentrations of metal may sometimes be detected in the surface drainage system up to several miles downstream from mineralization. Where such geochemical dispersion does exist, the systematic sampling of stream-water or alluvium may constitute a useful aid in the rapid mineral reconnaissance of comparatively large areas. Sampling and analysis of stream alluvium for metals extractable at normal temperatures have given particularly encouraging results in reconnaissance for copper and base metal deposits.

The practical application of geochemical methods has been made possible only by the development of extremely rapid, simple tests and there are now trace analytical techniques for a wide range of metals capable of being performed with adequate accuracy by semi-skilled personnel. For the most part, these tests are simplified versions of classical colorimetric and chromatographic methods, although spectrographic, fluorimetric and other procedures may be utilized for particular problems.

Current research is active and aimed at broadening the scope of existing methods, extending knowledge of dispersion processes, investigating the regional approach to comprehensive geochemical reconnaissance and developing appropriate analytical techniques. Progress in the application of geochemical techniques indicates that, when used in conjunction with geological, geophysical and other sources of information, they will play an increasingly greater part in modern mineral exploration. (*Nature*, 181, 594, 1958.)

CLAY MINERAL STUDIES

J. SHEARER

Department of Physics, University of Western Australia, Nedlands, W.A.

General

CLAY is the term applied to material naturally occurring in a finely divided state in sediments and in soils, and exhibiting under suitable hydration the property of plasticity. The degree of hydration required for the material to be plastic occurs when the added water is in excess of the amount that can be adsorbed on the surface of the clay mineral particles with some definite configuration. Clay commonly comprises a mixture of one or more aluminium silicate minerals characterised, in general, by their layer structure, and a limited amount of foreign material comprising non-clay minerals and organic matter.

It is the occurrence in soils that is perhaps of special interest. Clay minerals commonly constitute the bulk of the colloid fraction of a soil and so they are of special importance to the soil scientist. They occur as products of the weathering process. The type of clay or clay mixture occurring in a soil depends on many factors, such as nature of the parent rock, climate and topography. Distribution in depth is an interesting study in relation to the weathering process for under ideal conditions of uniform climate over a sufficient period of time and favourable topography and drainage one may expect to find the weathering sequence extend from parent rock beneath to the most highly weathered product near the surface.

Of special interest in agriculture is the study of the occurrence and properties of clay minerals in relation to plant nutrition and soil fertilisation and to soil classification. These relationships are obscure with the result that the full significance of a mineralogical analysis in the case of a particular soil has still to be determined.

Clay minerals are important in many fields of technological interest. In the oil industry certain clays have important catalytic activity. They are also used as drilling muds. The stability of engineering structures depends on the physical properties of the supporting soil and these properties will depend on the prevalence and kind of clay present. In the foundry industry clays are used for molding purposes in association with molding sands. The importance of clay mineralogy to the ceramic industry is obvious.

Structure

Although the number of recognized clay minerals is large, the number of groups is relatively small. The structures characterising common groups will be described in this brief review.

The majority of clay minerals are layer structures and of these the majority belong to the ideal type of aluminium silicates, the remainder to the ideal type of magnesium silicates. Isomorphous replacement alters considerably the chemical nature of these two types. The two types may be described as follows:

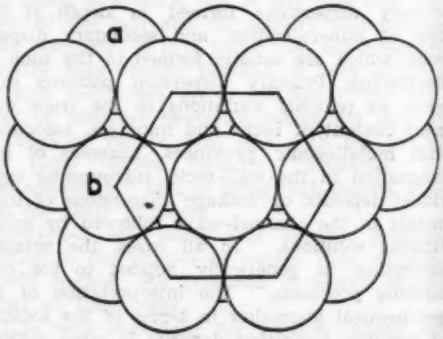


FIG. 1

Fig. 1 represents in plan two indefinitely extended sheets, parallel to the plane of the paper and one on top of the other, of close-packed OH ions. Ions like *b* are in the upper sheet. Ions like *a* are in the lower sheet. Midway between these two sheets, where gaps in the upper sheet overlie gaps in the lower sheet, are centres of octahedral co-ordination. For example ion *b* is one apex of an octahedron of which ion *a* is the other apex.

Just as there are the same number of OH ions in each of the two OH sheets so there are as many octahedral centres as there are ions in each of the two sheets.

In the ideal type of magnesium silicate clays the octahedral centres are occupied by Mg ions, giving $Mg(OH)_2$. In the other ideal type—$Al(OH)_3$—two-thirds of the octahedral centres

are occupied by Al ions. Since the ratio of occupied octahedral sites in the two ideal type is 3 : 2 they have been termed trioctahedral and dioctahedral respectively. In clay minerals, in spite of extensive replacement and variation from the ideal 3 : 2 ratio, the distinction between the two types tends to be preserved.

The silicate contribution to the two types is a tetrahedral layer made up as follows:

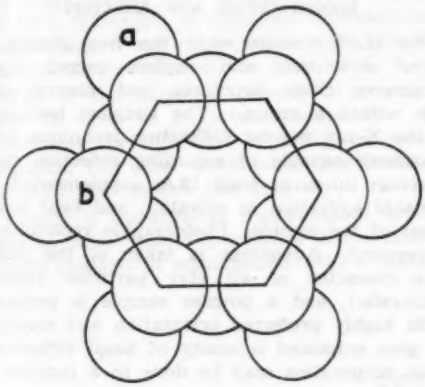


FIG. 2

Fig. 2 represents linked $(SiO_4)^{4-}$ tetrahedra (Si not shown) indefinitely extended in all directions in the plane of the paper. The formula is $(Si_2O_5)^{2-}$. All O ions like *b* lie in a plane above that containing O ions like *a*. Each ion like *b* is the apex of a tetrahedron and directly beneath each such ion is a tetrahedral centre (not shown) occupied by a Si ion.

The first group of clay minerals belongs to the dioctahedral type. The octahedral and tetrahedral layers are combined as follows. In Fig. 1 the six OH ions in layer *b* occurring at the six vertices of the hexagon shown are replaced by the six O ions in layer *b* in Fig. 2. In the resulting composite structure indefinitely extended in 2 dimensions valency is satisfied and the formula is $Al_2O_3.2\,SiO_2.2\,H_2O$. This is the Kandite (or Kaolin) group, and the successive sheets of ions and the relative number of ions in each sheet may be represented thus:

3 O
2 Si Tetrahedral centres
2 O + OH
2 Al Octahedral centres
3 OH
3 O
.
.

There is a strong bond between the sheet of O ions and the adjacent sheet of OH ions. The different ways in which these two sheets are disposed in relation to one another differentiate the minerals within the kandite group. In halloysite a molecular sheet of water about 2·9 A thick intrudes between sheets giving a basal spacing (perpendicular to the sheets) of 10·1 A. The basal spacing of other members of the group and of the dehydrated form of halloysite (namely, metahalloysite) is about 7·1 A. A very small cation exchange capacity observed for this group of clay minerals is attributed to broken bonds at surfaces.

Layer clay mineral structures other than the kandite group arise from a slightly more complicated way of combining octahedral and tetrahedral layers. Each of the two OH sheets of an octahedral layer may be modified to take a tetrahedral layer. The dioctahedral composite type may then be represented

3 O
2 Si Tetrahedral centres
2 O + OH
2 Al Octahedral centres
2 O + OH
2 Si Tetrahedral centres
3 O
3 O
.
.
.

The bond O to O is a van der Waals bond. The trioctahedral type will have 3 Mg replacing 2 Al in octahedral centres. The two formulæ are $Al_2O_3.4\,SiO_2.H_2O$ and $3\,MgO.4\,SiO_2.H_2O$ respectively. Two non-clay minerals, pyrophyllite and talc, occur in nature with these ideal formulæ. By reference to these two minerals the structures of two more groups of clay minerals—clay micas and smectites (or montmorillonoids)—may be illustrated. Both arise from substitutional replacement accompanied by interlayer cations interrupting the van der Waal's bond.

In clay micas some of the Si is replaced by Al in tetrahedral centres, and the charge deficiency is balanced by interlayer K. Some randomness of stacking of adjacent layers occurs. On an external surface the K is exchangeable. Clay micas are usually dioctahedral like muscovite. In fact muscovite may be regarded as a highly crystalline form of clay mica with more Al in tetrahedral centres, more bound interlayer K and less H_2O; hence arises the

term "hydrous micas" for all forms of clay micas. The basal spacing of clay micas is about 10 A. Hydration accompanied by reversible expansion to 12 A (perhaps 10 + 2·9) is sometimes observed. Clay micas with "fixed" basal spacing are termed illites.

In smectites the charge deficiency arising from substitutional replacement is balanced by interlayer cations that are exchangeable. The exchange capacity of these clays is therefore high. Water and other polar molecules also enter between layers. This process is reversible and so this clay group is characterised by high expansibility. When saturated with water, the basal spacing is about 15 A. When dehydrated and collapsed by heating, it is about 10 A as in mica. When treated with glycerol the basal spacing is 18 A.

Two dioctahedral members of this clay group are montmorillonite and nontronite. In the former about 1 in 6 Al ions are replaced by Mg. Nontronite is characterised by a balanced substitution of Fe for Al in octahedral centres and a charge deficiency in tetrahedral centres arising from substitution of Al for Si. Saponite is a trioctahedral member with tetrahedral substitutions similar to those in nontronite.

Clay micas and collapsed smectites may both be regarded as being of mica type. One other clay group which is also a mica type is vermiculite. This is another expansible mineral with a basal spacing, when collapsed, of approximately 10 A. When fully hydrated or treated with glycerol the basal spacing expands to 14 A. It is basically a trioctahedral mica like biotite with charge deficiency arising from tetrahedral substitution of Al for Si. Interlayer cations (predominantly Mg) and interlayer water complete the structure. The cation exchange capacity is again high as in the case of smectites.

A fifth group of clay minerals which comprise a distinct type from the kaolinite group and the mica group is the chlorite group. This group is characterised by a fixed basal spacing, unaffected by heating, of 14 A and a cation exchange capacity about the same as that for clay micas. Structurally it is trioctahedral like biotite with charge deficiency arising from tetrahedral substitution of Al for Si. But in this case the charge deficiency is balanced not by cations but by another trioctahedral layer with equivalent *excess* charge arising from replacement of Mg by Al in octahedral centres. Chlorite occurs in clays as well as in highly crystalline form, and is similar to vermiculite in this respect. The distinction may be similar to that between clay micas and highly crystalline micas.

Apart from the five groups of layer structures above described, there is X-ray evidence for the occurrence of mixed layer structures with random interstratification of, for example, mica and montmorillonite. Finally there is a group of clay minerals showing chain or fibre structure instead of layer structure.

Identification and Analysis

We shall consider only the five groups of layer structures, and neglect mixed layer structures, chain structures, and mineral species within a group. The simplest technique is the X-ray powder diffraction technique with a camera capable of recording reflection from spacings up to at least 18 A, supplemented by suitable hydration or solvation and heat treatment of the sample. Photographic recording is convenient. Advantage is taken of the plate-like character of all clay particles (except halloysite), and a powder sample is prepared with highly preferred orientation and mounted to give enhanced intensity of basal reflections. This preparation may be done in a number of simple ways.

Approximately pure samples may be identified as follows. Assume the sample has been treated with glycerol.

	1st order Basal Spacing	Basal Spacing after heat treatment at 600° C.
Kandite	7 A	Destroyed
Mica	10 A	10 A
Smectite	18 A	10 A
Vermiculite	14 A	10 A
Chlorite	14 A	14 A

So that ideally the first order basal spacing of glycerol-treated "oriented" specimen is sufficient, except to distinguish vermiculite and chlorite. Then the heat treatment is essential, unless chemical methods (and they have been suggested) are adopted. The heat treatment is always desirable, particularly to avoid confusion between first order Kandite and second order vermiculite or chlorite.

When dealing with mixtures of clays heat treatment is essential. Quantitative analysis of such mixtures is difficult. Further evidence is sometimes then invoked provided by differen-

tial thermal analysis or chemical analysis. The accuracy is low so that the method of standard mixtures may be used even though it is impossible to rely on the identity of the standard mineral and the mineral in the unknown mixture. Kandites are much less susceptible to isomorphous replacement and can reasonably be assumed identical from standard to sample. The effect of composition on intensity may be considerable. For example, the intensities of 10 A reflections of collapsed montmorillonite and collapsed nontronite, each with interlayer K, are theoretically in the ratio of 1 : 9.

One of the minerals present in a mixture may be used as an internal standard. This overcomes the difficulty of using an external standard, but other assumptions are inevitably involved that reduce the accuracy.

Finally a quantitative mineralogical analysis may be made from a qualitative X-ray mineralogical analysis in combination with a chemical analysis for SiO_2, Al_2O_3, MgO, K_2O, lattice Fe_2O_3 (*i.e.*, total Fe_2O_3 less free Fe_2O_3) and ignition loss at 900° C. If a mica is present the amount may be assessed from the amount of K_2O. If a smectite is present it may be assumed to be of composition intermediate between a pure Mg species (montmorillonite) and a pure Fe species (nontronite). The amount (and composition) of the smectite may be estimated from the amounts of MgO (giving the amount of montmorillonite component) and of lattice Fe_2O_3 (giving the amount of nontronite component). This procedure for a smectite neglects the possibility of the existence of a pure aluminium silicate smectite analogous to muscovite mica.

Each unknown clay mixture to be mineralogically analysed, must be treated as a separate problem, particularly because non-clay minerals involving Si, Al and Fe may also be present.

THE TWISTOR

A NEW concept in memory devices has emerged from exploratory work by A. H. Bobeck at Bell Telephone Laboratories. This concept, which has been named the "Twistor", is expected to make possible, memory systems which are simpler to fabricate and more economical to manufacture than existing systems.

The "Twistor" concept opens the way for the construction of magnetic memory arrays by merely interweaving horizontal copper wires and vertical magnetic wires, in much the same way as a window screen is woven. Such a device would be similar in appearance to a ferrite core array, but without the cores, and would operate in much the same manner as a core array.

This new concept gets its name "Twistor" from a characteristic of wire made of magnetic material. Torsion, applied to such a wire shifts the preferred direction of magnetization from a longitudinal to a helical path. The coincidence of a circular and a longitudinal magnetic field can then be used to insert information into this wire in the form of a polarized helical magnetization, and the magnetic wire itself can be used as a sensing means.

In practice, the circular magnetic field is provided by a current pulse through the magnetic wire, and the longitudinal field by a current pulse through the copper wire which is perpendicular to the magnetic wire. Thus, storing a bit requires two coincident current pulses. One pulse by itself is insufficient to store a bit. Readout is accomplished by overdriving the longitudinal field in the reverse direction. The readout signal is sensed across the magnetic wire. Because the lines of magnetic flux along the helical path wrap the magnetic conductor many times, a favourable increase in the output signal is obtained.

Present indications are that the drive circuits for a "Twistor" array can be readily transistorized. Thus, a memory system using the "Twistor" concept will retain all of the advantages of ferrite core or sheet systems, and will be much simpler and more economical to fabricate. (*Frank. Inst. Jour.*, Feb. 1958.)

LEVELS OF ORGANISATION IN CELL FUNCTIONS

A. SREENIVASAN

Department of Chemical Technology, University of Bombay

IT is the most extraordinary phenomenon of nature that in the enzymatic events controlling life processes there is present a great deal of direction, order and co-ordination all of which show themselves by way of a harmonious and healthy existence. This order sets in right from cell division and multiplication. Thus, from the very beginning in the life of the fertilizing egg, the development of each tissue is co-ordinated with that of all others and this harmonious integration is apparently maintained by elaborate systems of physiological control throughout the life-span of the organism. The living form is thus an intricate and highly developed mosaic of varying and individually specific components.

For a fuller understanding of the basic chemical phenomena underlying this organisation, it has become incumbent to study isolated systems, away from the whole organism. In this process however there must be a clear recognition of the organisational features lost.[1] For, it is axiomatic in biology that the organism is more than the sum of the component tissue. An excised heart can be made to live outside the animal organism for several hours. Muscular contractions and relaxations can be observed with isolated muscle fibres for quite some time. Yet these components contribute more to the life processes that constitute the complicated morphological forms of complete animals.

Notwithstanding the arrangement and integration of parts at each level of complexity, a considerable amount of knowledge has accumulated through independent developments in the fields of enzyme chemistry and cytology. During the last two decades, chemical events in the body have been examined by a variety of means at the cellular and even sub-cellular levels. One of the first attempts in this direction has involved histological studies with tissue preparations. Even greater progress has been made on the dynamics of cellular processes through respiratory studies with tissue slices, homogenates and particulate fractions. This bold approach has paid excellent dividends and literally hundreds of different enzymatic mechanisms have been uncovered. An ever-increasing number of the finer reaction mechanisms that contribute to the sum total of metabolic processes are now explicable in terms of simple chemical equations. Such studies have for example enabled *in vitro* reconstruction of the entire process of glycolysis by adding together some twenty different enzymes that include phosphatases, phosphorylases, kinases, enolases, isomerases, mutases and dehydrogenases. The synthesis of starch, glycogen, sucrose, etc., could now be accomplished by relatively simple model reconstructions. From studies on such isolated systems one could go into integrated pictures of larger areas of metabolism and physiologic behaviour.

Sub-Cellular Fractions

This concerted attack on the enzymic armoury of the plant and animal kingdom has revealed an unique architectural pattern or 'chemical geography' within the living cell itself. In other words, there is a beautiful though complex structural pattern in the cell which is equalled only by a similar complex chemical organisation. In fact, it could be argued that cellular architecture has evolved itself in such a way as to permit an orderly sequence of metabolic processes or spatial disposition of enzymatic units which excludes interference among the many biochemical reactions that occur simultaneously.[2,3] Thus, specific cellular structures have apparently specific chemical properties. Systematic procedures in cell fractionation techniques have been devised for the isolation of cytoplasmic elements by means of differential centrifugation in isotonic media of broken cell suspensions.[4,5] It is now well recognized that there are only limited numbers of particle types which are sharply distinguishable from one another by specific enzymatic properties and chemical characteristics.[2] Thus a heavy nuclear fraction with relatively less activity for most enzymes is followed by a grayish mitochondrial residue with a whole hodgepodge—but NOT a random hodgepodge—of enzymes and there is left a supernatant which could be further resolved at high speed into sub-microscopic microsomes and a soluble non-sedimentable fraction. The characterisation of the enzymatic and other properties of these sub-cellular fractions are now the subject of intensive study in different laboratories. The nuclei contain all the desoxy-ribose nucleic acid (DNA) of the cell and are responsible for the transmission of species characteristics. They are nearly devoid of oxidizing enzymes. Most of these and especially those concerned with the oxidation of the Krebs cycle intermediates re-

side in the mitochondria. On the other hand, the entire group of enzymes concerned with glycolysis are in the soluble phase. Thus, the breakdown of glucose into carbon dioxide would imply the participation sequentially of the enzymes in the supernatant and those in the mitochondria. It seems that at least with diphosphopyridino nucleotide (DPN) the enzyme system responsible for the synthesis of this coenzyme resides in the nucleus.[6] This would indicate a biochemical interaction between the nuclei and the cytoplasmic contents. Doubtless there are other similar such relationships.

Mitochondria

Numerous recent reports have concerned themselves with the properties of the mitochondrial bodies. They are found in all types of animal cells as well as in other forms of plant and microbial life. They have however been studied more extensively in the animal cells.[3] To the cytoenzymologists, they are always the characteristic landmarks in the intracellular landscape and represent the physical housing for a complex of enzymes, a kind of 'chemical microkitchen'. Among these enzymes are those responsible for the oxidation of the Krebs intermediates, fatty acids and certain amino acids.[7,8] While it is possible for any one enzymatic process to be isolated for purposes of study from the other processes catalysed by this complex, none of the enzymes can be separated from the others in the complex except by rather drastic means. Enzymes show varying tendencies to be detached from the mitochondrial bodies.[9] A whole spectrum of split products intermediate between the mitochondrion and soluble protein can be covered by the application of various devices for fragmenting and disintegrating mitochondria. In such manipulations probing into the mitochondrion, there is again considerable loss of organisational features.

Oxidative Phosphorylation

Of special significance in this connection is the fact that the mitochondrion is also the seat of all oxidative phosphorylation.[8,10] In the oxidation of the substrates of the citric acid cycle by the mitochondrial enzymes, the need is felt for addition of inorganic phosphate, adenosine-5-phosphoric acid (AMP) or, more strictly, adenosine-diphosphate (ADP) and Mg^{++}.[7,11,12] Otherwise, oxidation slows down after a while. In the unfractionated tissue homogenate representing the entire cellular material, no such additions are observed to be necessary. This will therefore denote a lower degree of organisation in the mitochondria as compared to the cell. The fact is, oxidations in the cell are coupled with simultaneous initiation of various endergonic reactions. This problem of energy transmission is fundamental to our understanding of the chemistry of the cell. If the two processes can occur in close juxtaposition at the respective enzyme surfaces the possibility of the dissipation of energy produced in the reaction as heat is reduced enormously. The oxidative processes thus enable the cell to do osmotic work, mechanical work such as contraction, ciliary movement and chemical synthesis. Unexpended energy of oxidation is stored as adenosine triphosphate (ATP) and phosphocreatine.

In a purified mitochondrial system, an oxidative process does not proceed unless there is an acceptor of the high energy bond (~) which could be formed as follows[7]:

$$-2e$$

1. Substrate + oxidase $\longrightarrow$ Oxidized substrate ~ reduced oxidase.
2. Oxidized substrate ~ reduced oxidase + phosphate $\rightarrow$ Phosphate ~ reduced oxidase + oxidized substrate.
3. Phosphate ~ reduced oxidase + ADP $\longrightarrow$ reduced oxidase + ATP.

According to this concept, phosphate is not necessary for the primary reaction. However, in its absence, the primary complex is stabilised and the over-all reaction velocity becomes limited by the spontaneous rate of breakdown of this complex. Like AMP or ADP, various energy-requiring systems could be equally well coupled with the oxidation. Thus, glucose and hexokinase (not present in mitochondria) or creatine and creatine phosphopherase or thiamine and carboxylase can be added. They are referred to as trapping systems for the $\sim PO_4$. Alternately, adenosine triphosphatase (ATPase) can be added. The respiration of mitochondrial preparations is enhanced by additions of nuclei or supernatant preparations because of their contributions of ATPase or of endergonic systems.[11] ATPase functions by breaking down the $\sim PO_4$. Other uncoupling agents that could act at this step and thus promote oxidation without esterificaion of inorganic PO_4 are dinitrophenol, atabrine, certain antibiotics, thyroxine, barbiturates, and so on. There is a suggestion that there may be fundamental differences in the mechanism by which various agents uncouple oxidative phosphorylation in mitochondria.[13]

Thus, in addition to the organized chain of carrier enzymes which transfer electrons from substrate to oxygen, the mitochondria possess the auxiliary enzyme system which couple phosphorylation of ADP to the exergonic electron transport process. The number of phosphate molecules esterified per mole of substrate oxidized in a single two-electron step, usually expressed as the P/O quotient (disappearance of inorganic phosphate : Oxygen uptake) is approximately three[12,13] and corresponds to a thermodynamic efficiency of some 60-70%.[10] Two of these coupled phosphorylation mechanisms are located between reduced DPN (DPNH) and cytochrome C and the third between cytochrome C and oxygen.[14,15]

Mitochondrial Structure and Function

The most important property of the mitochondrial bodies resides in their efficient use of oxidisable substrates. The morphological and physical properties of mitochondria have attracted special attention because they are closely interlinked with mitochondrial functions. The mitochondria in living cells appear under an electron microscope like beaded rodlets enveloped by a membrane having an inner and an outer zone.[3,9] The presence of this membrane and its importance have been repeatedly brought out from various biochemical studies. When isolated freshly in hypertonic sucrose, a large number of these particles retain their original rod-like structure although a good per cent. of spherical forms are also present. The transformation to spherical shapes is complete on further dilution of the suspending medium.[9] The morphological alteration from elongated to spherical shape at isotonic concentrations however is not accompanied by any major changes in the biochemical properties of the mitochondria. Preparations with isotonic sucrose are widely used for various studies and represent the choicest material for study of oxidative phosphorylation. Actively metabolising mitochondria control the transport of solute and water across their membranes[16] and are known to concentrate to a small but significant extent certain ions, Krebs intermediates, etc.[17,18] This selective power of mitochondria which is energy-dependent is efficiently geared to the systems participating in electron transport and phosphorylation and points to the active and semipermeable nature of the surrounding membrane.

However it has become apparent during studies on oxidative phosphorylation that the mitochondrial membrane has a limited ability to carry out these functions and to maintain the integrity of mitochondrial structure and its activities. Kielley and Kielley[19] found that the synthesis of ATP was rendered inoperative by any procedure resulting in structural damage to mitochondria. A number of factors are known to cause a swelling of these particles due to imbibition of water. Exposure to hypotonic conditions, ageing, presence of traces of heavy metal ions or certain anions, other environmental alterations and physiological states result in an acceleration of swelling of mitochondria which may finally lead to their disintegration into smaller particles.[16,26] Mitochondria in intact cells have also been shown to be sensitive to such changes.[21] Among the biochemical alterations observed are the loss of several intramitochondrial components such as nucleotides and other co-factors, certain ions involved in oxidative phosphorylation and small quantities of soluble proteins.[20] Inhibition of certain enzymes and an activation of others which are latent in fresh mitochondria, especially of ATPase,[19,27–30] and an extreme lability of oxidative phosphorylation system in homogenates and mitochondria[19,21,26] have been consistently reported.

Several attempts at prevention of the swelling of the mitochondria as well as restoration of oxidative phosphorylation, by returning the component(s) presumed to be lost once the swelling had taken place, have met only with partial success.[17,18,31] Protection by adenine nucleotides and Mg^{++}[5,26,32,33] had been observed. Similarly addition of DPN has reportedly some effect.[25] Nearly complete restoration on addition of trichloroacetic acid extracts of fresh mitochondria has also been observed to occur.[32]

It seems evident that the swelling of mitochondria precedes rather than follows the uncoupling phenomenon. Little is known about the events which lead to the swelling of these particles under unfavourable conditions nor about the mechanisms by which phosphorylation is restored on addition of mitochondrial extracts or components. The concept that a supply of ATP is essential at all times for maintenance of mitochondrial integrity is probably not satisfactory.[34] It has been suggested that the swelling of mitochondria is probably an enzymic process rather than a disappearance of any protecting mechanisms.[35] Thus lysolecithinase from snake venom could act on mitochondrial phospholipids (in which it is rich) to give rise to lysolecithin which attracts water molecules with subsequent distortion, swelling, and even rupture of the membrane. However, the pre-

sence of lysolecithinase in mitochondria remains to be demonstrated. Again it has been observed that the swelling is more rapid under aerobic conditions and there is the possibility that oxygen reacts directly with a certain key group probably sulphydryl.[34] Thus, in contrast to the slow and relatively limited swelling produced by other methods, sulphydryl binding agents produce a rapid and more pronounced swelling, suggesting the participation of free sulphydryl groups in the maintenance of mitochondrial structure and/or permeability.[36]

Particulate but no longer mitochondrial systems capable of catalysing phosphorylation during the oxidation of selected substrates have recently been obtained by Lehninger *et al.*[37] by digitonin extraction of rat liver mitochondria and by Green *et al.*[38] by fragmentation of beef heart mitochondria and fractional separation in presence of ethanol and phosphate. Although therefore it seems possible to obtain functional and structural sub-units of the parent mitochondrion, the question as to whether these particles capable of both oxidation and phosphorylation are vesicular or solid cannot be definitely answered at the present time.[39] The fact that they do bind K^+ like the intact mitochondria[40] would suggest a re-evaluation of the role of the mitochondrial membrane.

Despite recent achievements on the isolation of sub-cellular electron transport particles it would seem necessary to concede to the importance of mitochondrial integrity for the maintenance of oxidative phosphorylation and therefore of normal cellular metabolism. An expendable structural feature of an enzyme housing in an *in vitro* system may not be so in the complex milieu of the living cell. In a consideration of protein structure to function, Steinberg and Mihalyi[4] point out that "non-essential" features of enzymes and other biologically essential molecules may arise from their role in orienting the active protein to other structural features and enzymes in the cell. They may also determine its thermodynamic efficiency in the cell under different physiological conditions.

Vitamin B_{12} and Oxidative Metabolism

Subtle changes in the geometrical organization of the multi-enzyme arrays and the matrix in which these functionally interdependent units are housed are conceivable under different biological conditions and hence intracellular control of oxidative phosphorylation may occur at any one of several sites in the coupling processes susceptible to interference. Indeed, it is now recognized that uncoupling of oxidative phosphorylation could arise out of diverse known and unknown modalities.[13]

A reference may now be made to certain suggestions implicating vitamin B_{12}, albeit indirectly, in the control of mitochondrial morphology. The observations have arisen from studies on protection afforded by this vitamin against experimentally induced thyrotoxicosis or liver injury.

When small quantities of an iodo-protein are included in the diet of experimental animals or when small doses of thyroxine are given to them parenterally, they show increased requirement for several of the food factors—among them, chiefly, B vitamins. This is a recognized procedure for induction of deficiency in certain of the B vitamins, the others being given in excess. Of especial significance is the increased requirement for vitamin B_{12}. In thyrotoxic rats, there is usually a rapid weight loss and when this comes to about 10% the animals rapidly die off.[42] If excess B_{12} is present in the diet, there is protection against weight loss and mortality.[43]

Again, a single injection of the steatotic poison carbon tetrachloride can cause fatty liver in the rat. This degeneration is also protected against by prior administration of vitamin B_{12}.[44]

Uncoupling of oxidative phosphorylation has been reported in experimentally induced hyperthyroidism[42,45,46] as well as in steatotic liver injury.[47] Mitochondrial preparations from such livers show a good parallel in their behaviour and characteristics with normal mitochondria subjected to hypotonic conditions. They have lowered pyridine[45,48] and adenine[49] nucleotide levels, and exhibit decreased oxygen consumption[50,51] and lowered P/O ratios.[45,47] No effect of CCl_4 could be seen on mitochondrial integrity in *in vitro* studies.[47] Though *in vitro* uncoupling of oxidative phosphorylation by thyroxine has been reported,[52–55] this is not observed to take place in mitochondria held in isotonic sucrose.[49] Thus, thyroxine is effective *in vitro* only when the hormone is pre-incubated with mitochondria[56] or when the mitochondria are subject to hypotonic conditions[57] in its presence so as to facilitate entry of the hormone. Thyroxine acts by binding Mg^{++} once it enters the mitochondria[58,59] and thyroxine-induced uncoupling could be reversed by Mg^{++}. Thyroxine also fails to uncouple oxidative phosphorylation[60] in digitonin preparations[37] of mitochondria. These results are therefore suggestive of the fact that any *in*

vitro effect of thyroxine is not due to direct interference with the enzymes of oxidative phosphorylation and that its effect as well as that of CCl_4 *in vivo* could arise from an impairment of mitochondrial integrity due to osmotic damage. This phenomenon obviously underlies the observed uncoupling of phosphorylation from respiration.

In recent work from this laboratory,[61,62,44,63] it has been demonstrated that, in experimentally induced nutritional stress such as thyroprotein feeding or CCl_4 poisoning, there is depletion of tissue vitamin B_{12} levels and an impairment of several metabolic processes. A disturbance in glutathione metabolism and of osmotic damage to mitochondria precede all other derangements. A rapid reduction in liver stores of glutathione in the CCl_4-poisoned rat has also been reported by Patwardhan and coworkers.[64] Tapley and Cooper[36,65] observed that the action of thyroxine *in vitro* is probably due to its primary action on mitochondrial structure. Dianzani has made similar observations in steatotic rats.[47,48] Since oxidative phosphorylation is the only major pathway linking energy-requiring with energy-yielding processes, it is obvious that the uncoupling produced by mitochondrial swelling is reflected as metabolic derangements.

It has been suggested that the nucleotides are bound to sites in the mitochondria which are probably also the ones at which oxidative phosphorylation takes place. It would appear that the immobilisation of co-factors like AMP, ADP, DPN, Mg^{++}, etc., from their site of activity makes them unavailable for participation in oxidative phosphorylation. It is also possible that the nucleotides are bound to proteins enzymatically active and confer stability on these enzymes and that unbinding and subsequent loss of these from mitochondria makes the proteins more labile and enzymatically inactive.

The morphological and metabolic derangements of hyperthyroidism and fatty infiltration are all protected against by vitamin B_{12} *in vivo*.[61,44,63] An interesting feature relates to changes in pyridinonucleotides (PN). A marked reduction in PN and a decrease in PN/PNH (oxidised to reduced pyridinonucleotides) in CCl_4 toxicity suggests a shift of fatty acid metabolism towards synthesis. PN is important because it is concerned in oxidation of fatty acids and in at least 3 steps in the citric acid cycle (isocitric, α-ketoglutaric and malic dehydrogenations) whose normal functioning is necessary for fatty acid oxidation. The influence of vitamin B_{12} on correction of CCl_4 damage is explicable in terms of its favourable effect on PN and PN/PNH.[66]

Since mitochondria are apparently protected against changes attendant on swelling by AMP or ATP,[25,26] DPN[25] and sulphydryl,[34,36] the protection observed with vitamin B_{12} might arise from its known role in nucleotide and sulphydryl metabolism. Obviously the diverse effects observed with this vitamin, in extremely small amounts, on the physiology of the animal organism must arise from a very basic function it has in cellular integrity and economy.

---

1. Szent-Gyorgyi, A., *Chemistry of Muscular Contraction, 2nd Edn.*, Acad. Press, 1951.
2. Hogeboom, G. H., Schneider, W. C. and Striebich, M. J., *Cancer Res.*, 1953, **13**, 617.
3. Palade, G. E., in O. H. Gaebler's, *Enzymes: Units of Biological Structure and Function*, Acad. Press, 1956, 185.
4. Claude, A., *The Harvey Lectures*, 1947–48, **43**, 121.
5. Holter, H., *Adv. Enzym.*, 1952, **13**, 1.
6. Hogeboom, G. H. and Schneider, W. C., *J. Biol. Chem.*, 1952, **197**, 611.
7. Green, D. E., *Biol. Revs.*, 1951, **26**, 410.
8. —, *J. Cell. & Comp. Physiol.*, 1952, **39**, Suppl. 2, 75.
9. Harman, J., *Expt. Cell. Res.*, 1950, **1**, 382, 394.
10. Lehninger, A. L., *Harvey Lectures*, 1953–54, **49**, 176.
11. Lardy, H. A. and Wellman, H., *J. Biol. Chem.*, 1952, **195**, 215.
12. Maley, G. F. and Plaut, G. W. E., *Ibid.*, 1954, **205**, 297.
13. Lehninger, in Gaebler (ref. 3), p. 217.
14. Nielson, S. O. and Lehninger, A. L., *J. Biol. Chem.*, 1955, **215**, 555.
15. Borlstroom, B., Sudduth, H. C. and Lehninger, A. L., *Ibid.*, 1955, **215**, 571.
16. Berthet, J., Berthet, L., Applemans, F. and de Duve, C., *Biochem. J.*, 1951, **50**, 182.
17. Bartley, W. and Davies, R., *Ibid.*, 1954, **57**, 37.
18. McFarlane, M. B. and Spencer, A. G., *Ibid.*, 1953, **54**, 569.
19. Kielley, W. W. and Kielley, R. K., *J. Biol. Chem.*, 1951, **191**, 485.
20. Harman, J. W. and Feigelson, M., *Exp. Cell. Res.*, 1952, **3**, 509.
21. Dianzani, M. U., *Biochem. et Biophys. Acta*, 1953, **11**, 353.
22. Schneider, W. C., *J. Histochem. and Cytochem.*, 1953, **1**, 188.
23. Chappell, J. B., and Graville, G. D., *Nature*, 1954, **174**, 930.
24. Tedeschi, H. and Harris, D. L., *Arch. Biochem. Biophys.*, 1955, **58**, 52.
25. Hunter, F. E. and Ford, L., *J. Biol. Chem.*, 1955, **216**, 357.
26. Siekevitz, P. and Potter, V. R., *Ibid.*, 1955, **215**, 221, 237.
27. Schneider, W. C. and Hogeboom, G. H., *Ibid.*, 1952, **195**, 161.
28. Lardy, H. A. and Wellman, H., *Ibid.*, 1953, **201**, 357.
29. Potter, V. R. and Siekevitz, P., *Ibid.*, 1953, **285** 897.

30. de Duve, C., Presman, B. C., Gianetto, R., Wittiaux, R. and Applemans, F., *Biochem. J.*, 1955, **60**, 604.
31. Price, C. A., Fonnesu, A. and Davies, D. E., *Ibid.*, 1956, **64**, 754, 769.
32. Dianzani, M. U., *Biochem. et Biophys. Acta*, 1956, **22**, 389.
33. Ernster, L. and Low, H., *Exptl. Cell. Res.*, 1955, **3**, 133.
34. Hunter, F. E., Davis, J. and Carlat, L., *Biochim. et Biophys. Acta*, 1956, **20**, 237.
35. Witter, R. F. and Cottone, M. A., *Ibid.*, 1956, **22**, 364, 373.
36. Tapley, D. F. and Cooper, C., *J. Biol. Chem.*, 1956, **222**, 341.
37. Cooper, C., Devlin, T. M. and Lehninger, A. L., *Ibid.*, 1956, **219**, 489, 507, 519.
38. Green, D. E., in Gaebler (ref. 3), p. 465.
39. Watson, M. L. and Siekevitz P., *J. Biophys. & Biochem. cyt.*, 1956, **2**, 639; *Biochim. et Biophys. Acta*, 1957, **25**, 275.
40. Gamble, J. L., *J. Biol. Chem.*, 1957, **228**, 955.
41. Steinberg, D. and Mihalyi, E., *Ann. Revs. Biochem.*, 1957, **26**, 373.
42. du Toit, C. H., in W. D. McElroy and B. Glass, *Phosphorus Metabolism*, Johns Hopkins Press, 1952, **2**, 597.
43. Fatterpaker, P., Marfatia, U. and Sreenivasan, A., *Nature*, 1951, **167**, 1067.
44. Kosbekar, D. K., Rege, D. V. and Sreenivasan, A., *Ibid.*, 1956, **178**, 989.
45. Maley, G. F. and Lardy, H. A., *J. Biol. Chem.*, 1955, **215**, 377.
46. Maley, G. F., *Ibid.*, 1957, **224**, 1029.
47. Dianzani, M. U., *Biochim. et Biophys. Acta*, 1954, **14**, 514.
48. Dianzani, M. U., *Biochim. et Biophys. Acta*, 1955, **17**, 391.
49. —, *Biochem. J.*, 1957, **65**, 116.
50. Chernick, S. S., Moe, J. G., Rodnan, G. P. and Schwarz, K., *J. Biol. Chem.*, 1955, **217**, 829.
51. Dianzani, M. U., *G. Biochimica*, 1953, **2**, 180.
52. Martius, C. and Hess, B. *Biochem. Z.*, 1955, **326**, 191.
53. Hoch, F. L. and Lipman, F., *Proc. Nat. Acad. Sci.*, 1954, **40**, 909.
54. Maley, G. F. and Lardy, H. A., *J. Biol. Chem.*, 1953, **204**, 435.
55. Klemperer, H. G., *Biochem. J.*, 1955, **60**, 122.
56. Martius, C. and Hess, B., *Arch. Biochem. Biophys.*, 1951, **33**, 486.
57. Tapley, D. F, Cooper, C. and Lehninger, A. L., *Biochim. et Biophys. Acta*, 1955, **18**, 597.
58. Bain, G. A., *J. Pharmacol. Exptl. Therap.*, 1954, **110**, 2.
59. Aebitt, J. and Alebin, L., *Biochem. Z.*, 1953, **324**, 364.
60. Cooper, C., Delvin, T. M. and Lehninger, A. L., *Biochim. et Biophys. Acta*, 1955, **18**, 159.
61. Fatterpaker, P., Marfatia, U. and Sreenivasan, A., *Nature*, 1955, **176**, 165.
62. Lavate, W. V. and Sreenivasan, A., *Ibid.*, 1956, **178**, 804.
63. Kasbekar, D. K. and Sreenivasan, A., *Ibid.*, 1956, **178**, 990.
64. Patwardhan, M. V., Ramalingaswami, V., Sriramachari, S. and Patwardhan, V. N., *Ind. Jour. Med. Sci.*, 1953, **7**, 553.
65. Tapley, D. F. and Cooper, C., *J. Biol. Chem.*, 1956, **222**, 325.
66. Nadkarni, G. B. and Sreenivasan, A., *Nature*, 1957, **180**, 659.

FREE RADICALS IN CIGARETTE SMOKE

IN attempts to determine a unifying principle of action for the many and varied carcinogenic agents, many workers have assigned an intermediary role to free radicals. It is stated that many, if not all, carcinogens are compounds capable of forming free radicals which may be stabilized as ions. Scientific workers have discussed their possible role in the production of tumours in rodents by implanted films of various high polymers, and suggested, as a requirement for tumour production, the presence of foreign free radicals in a specific area for an extended period.

Primary consideration is normally given to aromatic polycyclic hydrocarbons as active agents in tobacco carcinogenesis. However, in view of the above, it seemed of interest to determine the concentration of free radicals in cigarette smoke. A series of experiments, which utilized a high-sensitivity electron resonance spectrometer, have therefore been carried out. In order to prevent recombination of radicals as much as possible, the smoke was condensed at liquid-oxygen temperatures, and all measurements were made at this temperature.

The combined evidence from these experiments suggested that there is sufficient concentration of free radicals in cigarette smoke (when compared with the expected concentrations in the polymer experiments) to act as a carcinogenic agent if such a mechanism is possible. It is interesting to note in this connexion that the concentration of stable free radicals in atmospheric soot is about one hundred times larger than in cigarette smoke. But, as with the polycyclic hydrocarbons, adsorption on comparatively larger particles, and further stabilization as a result, are likely to render them inaccessible to the cells. (*Nature*, April 5, 1958.)

LETTERS TO THE EDITOR

LIPID DEPLETED ADRENAL CORTEX IN MOLYBDENUM FED RATS AND ITS PREVENTION BY VITAMIN E

An interrelationship between vitamin E and molybdenum has been observed in prolonged studies conducted on the action of this metal.[1,2] Certain enzyme systems, like alkaline phosphatase are enhanced, in livers of molybdenum-treated experimental animals and vitamin E is found to prevent this rise.[3] Vitamin E deficiency causes degenerative changes in the suprarenal cortex.[4] Likewise, administration of vitamin E has a stimulating effect on suprarenal activity.[5] In the present report, the histological structure of the suprarenal cortex of albino rats on a molybdenum, and molybdenum *plus* vitamin E dietary have been studied and compared with that of control experimental animals.

Young weanling albino rats were maintained on a standard casein diet. They were divided into three groups; one served as control, the second received a molybdenum fortified diet at a level of 100 p.p.m., and the third received the same diet as group two, with an additional supplement of vitamin E orally, 8 mg. per week. After maintaining for 6 months, the animals were sacrificed by cardiac bleeding. The adrenals were fixed in 10% formol and processed by the usual methods.

Fig. 1 represents the microanatomical structure of the suprarenal cortex under high

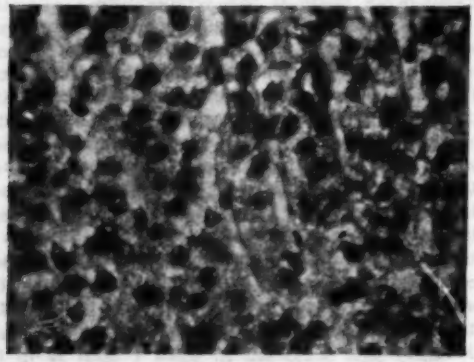


FIG. 1 *a*.

power. Fig. 1 *a* represents the normal lipid pattern in a typical adrenal cortex from a normal control animal. It can be noticed that the spaces are filled with lipid material. Fig. 1 *b* is from a representative animal on the molybdenum dietary. The histological picture indicates a necrosis with lipid depletion. Fig. 1 *c*

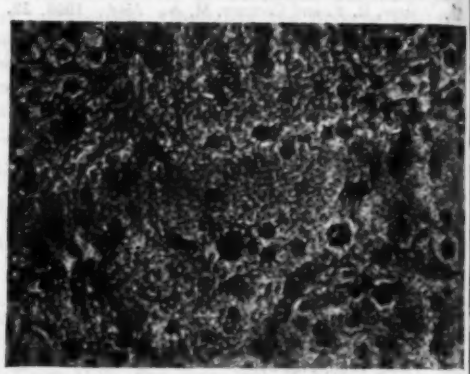


FIG. 1 *b*.

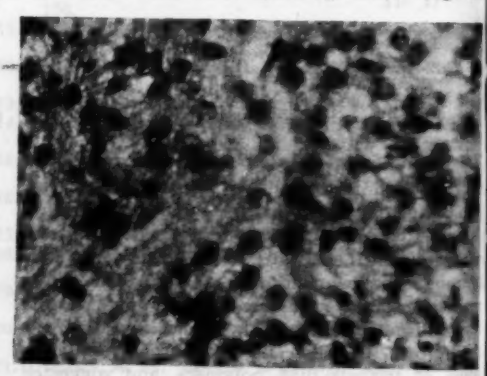


FIG. 1 *c*.

represents the effect of vitamin E on a molybdenum dietary as reflected by a return to normal of the lipid pattern. The effect of vitamin E is markedly pronounced, totally masking the effect of molybdenum.

The evidence presented here indicates that molybdenum suppresses suprarenal cortical function, resulting in structural alteration to this endocrine gland. Arrington and Davis[6] in the course of their studies on toxic molybdenosis in rabbits have indicated a paresis of the hind limbs accompanied by wasting of the pelvic region. It is highly likely that this con-

dition is a sequel to a molybdenum-induced cortical insufficiency giving rise to the manifestation of Addison's disease. Further work is in progress to evaluate the adrenal pituitary balance in experimental molybdenosis.

Dept. of Biochemistry, Institute of Science, Bombay-1, *January* 31, 1958.

P. P. NAIR.
N. G. MAGAR.

1. Nair, P. P., Doctoral Thesis : *Metabolic Interrelationship between Vitamin E and Molybdenum*, University of Bombay, December, 1956.
2. — and Magar, N. G., *Ind. J. Med. Res.*, July 1958 (in press).
3. —— and Bharadwaj, T. P., *J. Postgraduate Med.*, 1956, **2**, 163.
4. Brummer, L. H., *Ann. Acad. Sci. Fennicæ*, 1955, **45**, 57.
5. Heinsen, H. A. and Koker, H., *Deut. Med. Wschr*, 1951, **76**, 487.
6. Arrington, L. R. and Davis, G. K., *J. Nutrition*, 1953, **51**, 295.

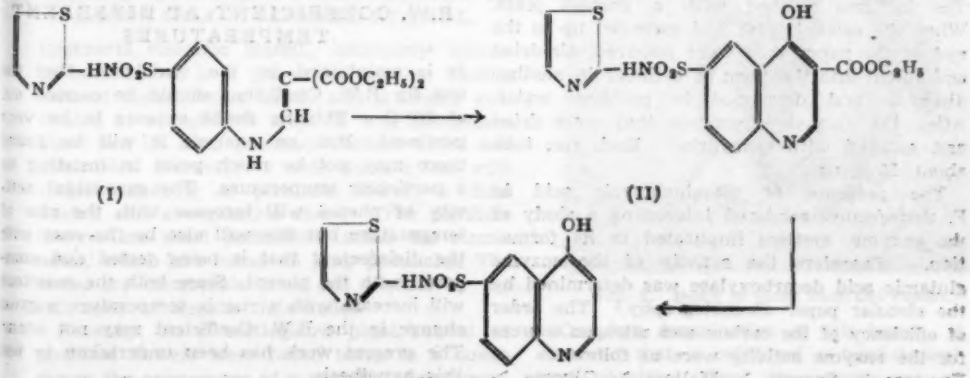
SYNTHESIS OF 4-HYDROXY-6-SULFONAMIDE-QUINOLINE DERIVATIVES

PRICE, LEONARD AND STACY[7] attempted to prepare 4-hydroxy-6-sulfonamide-quinoline by the application of ethoxymethylenemalonic ester synthesis to sulfanilamide but, all their attempts to cyclize the condensation product obtained from sulfanilamide and ethoxymethylenemalonic ester proved futile. Riegel *et al.*[2] also experienced the same difficulty with sulfanilamide. In our hands, the thermal cyclization of the sulfanilamide condensation product in boiling diphenyl ether, under controlled conditions, gave a pale yellow product, crystallized from nitrobenzene, m.p. 240° C. (with decom.). However, this could not be obtained in an analytically pure form.

Thinking that the free amino group of $-SO_2NH_2$ interfered in the smooth cyclization, a N^1-substituted sulfanilamide, *i.e.*, sulfathiazole was chosen and the reaction was repeated.

Expectedly, all the steps were smooth. Thus, on heating a mixture of sulfathiazole (1 mol.) and ethoxymethylenemalonic ester (1 mol.) in benzene the condensation product (I) was obtained in quantitative yield, crystallized from aqueous ethanol, m.p. 165-66° C. (Found : C, 48·3 ; H, 4·7 ; N, 9·7. $C_{17}H_{19}N_3O_6S_2$ requires C, 48·0 ; H, 4·5 ; N, 9·9.) The condensation product (I) on heating in boiling diphenyl ether under controlled conditions gave the cyclized product (II) in 93% yield, crystallized from nitrobenzene in rhombic needles, m.p., 281-82° C. (with decomp.). (Found : C, 47·2 ; H, 3·5 ; N, 11·7 ; S, 16·5. $C_{15}H_{13}N_3O_5S_2$ requires C, 47·5 ; H, 3·5 ; N, 11·1 ; S, 16·9.) The saponification of (II) was accomplished in quantitative yield by refluxing with excess of 10% sodium hydroxide for 2 hr. and subsequent neutralization. The acid (III), being very sparingly soluble in organic solvents, was directly decarboxylated by heating in boiling diphenyl ether for 1½ hr. The 4-hydroxy quinoline derivative (IV) obtained on cooling was washed with petroleum ether and finally crystallized from a large volume of nitrobenzene in shining microscopic needles, m.p., 312-13° C. (with decomp.), yield 83-84%. (Found : C, 46·7 ; H, 2·6 ; N, 13·3. $C_{12}H_9N_3O_3S_2$ requires C, 46·9 ; H, 3·0 ; N, 13·7.)

The condensation product from sulfaguanidine obtained in quantitative yield crystallized from aqueous ethanol, m.p., 186-87° C. (Found : C, 46·7 ; H, 4·9 ; N, 14·7. $C_{15}H_{20}N_4O_6S$ requires



(I) (II)

(IV)

C, 46·9; H, 5·3; N, 14·6), because of the presence of free amino groups, presented the same difficulty during cyclization. Work, now in progress to prepare 4-hydroxy quinoline derivatives from other sulfanilamides and their conversion to 4-alkylaminoquinolines for testing their biological activity, will be reported elsewhere.

Dept. of Chem. Technology, University of Bombay, Matunga, Bombay-19, *February* 27, 1958.

KASHINATH S. SARDESAI.
S. V. SUNTHANKAR.

1. Price, C. C., Leonard, N. J. and Stacy, G. W., *J. Am. Chem. Soc.*, 1947, **69**, 855.
2. Riegel, B. *et al.*, *Ibid.*, 1946, **68**, 2636.

GLUTAMIC ACID DECARBOXYLASE IN FUSARIA

DURING an investigation of the amino acid composition of Fusaria[1] by circular paper chromatography[2,3] γ-aminobutyric acid was identified in the acid hydrolysate of *Fusarium vasinfectum*. Confirmation for its presence was obtained by running a mixed chromatogram with an authentic and pure sample of γ-aminobutyric acid.[4]

A two-dimensional chromatogram using *n*-butanol-acetic acid-water (40 : 10 : 50) as the first solvent and pyridine water (80 : 20) as the second established the presence of this acid beyond doubt. The test solutions were spotted at one corner of a square filter-paper (25 × 25 cm.) which was rolled into the form of a cylinder, stitched at two points and dipped in the butanol solvent in a petri-dish at the bottom of a cylindrical jar of suitable size. The jar was covered with a greased plate. When the solvent front had ascended up to the end of the paper they were removed, air-dried and rolled into the form of cylinder in another direction and developed in pyridine water. After the two developments they were dried and sprayed with ninhydrin. Each run took about 25 hours.

The presence of γ-aminobutyric acid in *F. vasinfectum* rendered interesting a study of the enzyme systems implicated in its formation. Therefore the activity of the enzyme glutamic acid decarboxylase was determined by the circular paper chomatography.[5] The order of efficiency of the carbon and nitrogen sources for the enzyme activity were as follows:

Fructose > Sucrose > Maltose > Glucose > Manose > Lactose > Galactose.

$(NH_4)_2SO_4$ > NH_4Cl > NH_4NO_3 > KNO_3 > $NaNO_3$.

An alkaline pH had a deleterious effect on the enzyme activity while an acid environment had a favourable influence. The optimal enzyme activity was found at pH 4·5 and 30° C. The enzyme activity which was little in young cultures increased with age and coincided with the stage when the cells were in resting condition. It was at maximum on the 16th day. It gradually diminished when the cells started to autolyse.

Decarboxylation of L-glutamic acid to γ-aminobutyric acid is known to occur in plants, animals, bacteria and yeast. Details of investigations carried out on this enzyme of *F. vasinfectum* will be published elsewhere.

I am very grateful to Professors Dr. S. V. Anantakrishnan and Dr. T. S. Sadasivan for their guidance and encouragement.

Dept. of Chemistry, Madras Christian College, Tambaram, *March* 7, 1958.

S. NATARAJAN.*

* *Present Address*:—Research Assistant, Dept. of Biochemistry, Indian Institute of Science, Bangalore-3.

1. Natarajan, S., *J. Indian bot. Soc.*, 1958, **37** (In Press).
2. Giri, K. V. and Rao, N. A. N., *Nature*, 1952, **169**, 923; *J. Indian Inst. Sci.*, 1952, **34**, 95.
3. — and Nagabhushanam, *Naturwissenschaften*, 1952, **39**, 548.
4. — and Rao, N. A. N., *Curr. Sci.*, 1953, **22**, 114; *J. Indian Inst. Sci.*, 1952, **34**, 95; 1953, **35**, 343.
5. —, Radhakrishnan, A. N. and Vaidyanathan, C. S., *Nature*, 1952, **170**, 1025; *J. Indian Inst. Sci.*, 1952, **34**, 305; *Anal. Chem.*, 1952, **24**, 1677.

A SHORT NOTE ON THE TESTING OF R.W. COEFFICIENT AT DIFFERENT TEMPERATURES

IT is maintained in the text-books that the test for R.W. Coefficient should be carried out at 20° C. This no doubt appears to be very pertinent. But on analysis it will be found there may not be much point in insisting on a particular temperature. The germicidal activity of phenol will increase with the rise of temperature but this will also be the case with the disinfectant that is being tested and compared with the phenol. Since both the reactions will increase with a rise in temperature a gross change in the R.W. Coefficient may not occur. The present work has been undertaken to test this hypothesis.

TABLE I

Results

Rideal-Walker coefficients at different temperatures

Disinfectant	Reaction Temperature	1st Test: Dilution at which *S. typhi* are killed in 7½ mins.		1st Test: R.W.C.	2nd Test: Dilution at which *S. typhi* are killed in 7½ mins.		2nd Test: R.W.C.
		Disinfectant	Phenol		Disinfectant	Phenol	
DETTOL ..	15° C.	1 : 300	1 : 100	3	1 : 300	1 : 100	3
	20° C.	1 : 350	1 : 115	3·04	1 : 350	1 : 100	3·5
	25° C.	1 : 350	1 : 125	2·8	1 : 350	1 : 100	3·5
	30° C.	1 : 350	1 : 125	2·8	1 : 400	1 : 125	3·2
	35° C.	1 : 450	1 : 130	3·46	1 : 400	1 : 125	3·2
CYLLINE	15° C.	1 : 400	1 : 110	3·64	1 : 350	1 : 100	3·5
	20° C.	1 : 500	1 : 120	4·2	1 : 400	1 : 100	4
	25° C.	1 : 550	1 : 125	4·4	1 : 500	1 : 120	4·2
	30° C.	1 : 550	1 : 125	4·4	1 : 500	1 : 125	4
	35° C.	1 : 550	1 : 125	4·4	1 : 500	1 : 120	4·2

In the undermentioned experimental tests Lister strain of *Salmonella typhi* after five subcultures in broth has been used. Cultures treated with various concentrations of disinfectant have been transferred with a standard 4 mm. platinum loop, to nutrient broth tubes each 30 secs. and incubated at 37° C. for 24 hours. The results are given in the accompanying table.

As far as the above disinfectants are concerned, the various temperatures at which the tests have been carried out do not appear to affect the value of R.W. Coefficient materially.

Central Drug Res. Inst., A. MUKHERJI.
Lucknow, *December* 18, 1957.

A TERATOLOGICAL PHENOMENON IN *LAGENARIA SICERARIA* STANDL.

Lagenaria siceraria Standl., commonly known as bottlegourd, is a pubescent angular trailing herb of cucurbitaceæ family and is largely cultivated as a vegetable crop. It is a monœcious plant and its stem possesses distinct nodes and internodes. Normally, a node bears a leaf with single staminate or pistillate flower, a bifid tendril and a vegetative shoot. The pistillate flowers are short peduncled unlike the staminates, which are borne on long peduncles. The nodes are discernible from one another by the existence of angular internodes.

Recently, on a bottlegourd plant, about 40 pistillate flowers were found borne in a bunch giving the appearance of a pseudo-inflorescence, which is not the characteristic feature of this species. After setting, it looked like a bunch of fruits but only one such bunch could be recorded on the entire length of the vine (Fig. 1).

FIG. 1. Bunch of young fruits and flowers.

On close examination of this bunch, it was observed that it exhibited a teratological feature resulting from the shortening of the

internodes and fusion of the stem nodes. The emergence of leaf and shoot on the nodes were altogether suppressed. Only the bifid tendrils were present in a minute form on each node beside the fruit or pistillate flower, which confirmed this observation. The pistillate flowers were borne in acropetal succession on the main and side branches. They were normal, regular and epigynous like the rest on the vine.

Although various forms of abnormalities have been noted in cucurbitaceæ by Masters (1869), the present type of teratological phenomenon in *Lagenaria siceraria* Standl. was recorded for the first time.

Horticultural Res. Inst., Saharanpur, *December* 14, 1957.

L. B. SINGH.
S. N. SINGH.

1. Masters, M. T., *Vegetable Teratology*, London, 1869.

INFLUENCE AND MECHANISM OF ACTION OF LOW TEMPERATURE PRE-TREATMENT ON GERMINATION OF TOBACCO SEEDS

WORKING on the germination of tobacco seeds (*Nicotiana tabacum*) we find that the seeds of the flue-cured variety Harrison Special germinate poorly at high temperatures. The actual germination figures were 63·1% at 32·2° C., 31·8% to 38·6% at 35° C. and only 9·0% at 37·8° C. compared to over 96% between the temperature range of 17·8° C. to 27·8° C. In general these observations confirm the results obtained by Johnson *et al.*[1] and Kincaid.[2]

If, however, the seeds are pre-treated after soaking at low temperatures for various periods the germinating capacity increases very appreciably (Table I) when tested for germination at the same temperatures. This effect is similar to the numerous cases of 'after-ripening' of dormant seeds by stratification or by cold temperature treatment reported in literature.[3–5]

But there are three important differences: (1) the seeds of tobacco when treated were not dormant in the usual sense as they readily germinated almost fully between the temperatures of 17·8° C. to 27·8° C.; (2) the effect of pre-treatment, in general, was additive, i.e., longer the period of pre-treatment, better was the germination; and (3) the period of pre-treatment to which the seeds reacted was counted in hours and days compared to the treatment of months necessary for 'after-ripening' in the dormant seeds. The most comparable record seems to be that of germination of *Delphinium*,[6] which showed an increase from 82% to 92% at 15° C. (59° F.) and from 62% to 76% at 20° C. (68° F.) after pre-treatment for 4 days to the temperatures of 0·5° C. (33° F.) and 5° C. (41° F.) respectively. However, the differences between after-ripening of dormant seeds and the reaction to the low temperature treatments mentioned above may only be of a quantitative rather than of a qualitative nature.

In order to explain the observed facts it is suggested that germination in tobacco may be considered to consist of 2 stages:

Stage A.—The stage of 'after-ripening'. At this stage an inducer substance which may be termed as 'germigen' is produced in the seed, without which the next stage (i.e., the development of the seedling) cannot take place. In tobacco, this stage can proceed on at the low temperatures of 5·6° C. to 22·2° C. when wetted, although there is no visible germination at temperatures below 12° C. because such a temperature is lower than the minimum cardinal temperature for germination.

Stage B.—The stage of development of the seedling. This stage cannot be initiated until an adequate amount of 'germigen' is available in the seed, lack of which keeps the seed dor-

TABLE I

Percentage germination at different temperatures after pre-treatment of soaked seeds to low temperatures for various periods

Incubation Temperature	Pre-treatment Temperature	Duration of pre-treatment						
		No pre-treatment 0 hrs.	12 hrs.	1 day	2 days	4 days	6 days	8 days
37·8° C.	22·2°	9·0	11·2	13·7	13·4	20·1	23·4	26·7
35° C.	22·2°	31·8	36·7	31·2	33·4	49·6	63·2	63·0
	11·1°	38·6	41·7	50·1	58·9	80·0	88·6	87·0
	5·6°	36·7	40·6	40·6	43·0	51·1	61·1	68·2

mant in spite of other conditions being favourable.

It also seems that the quantity of 'germigen' required for germination at higher temperatures is larger than at lower temperatures and therefore more seeds remain dormant at the higher temperatures, the supply of 'germigen' being inadequate for this purpose. With pre-treatment a higher 'germigen' level is reached, and this results in comparatively high germination at all incubation temperatures; but as long as pre-treatment is incomplete, the trend of more number of seeds germinating at lower temperatures is maintained. When pre-treatment is adequate, as was obtained in some other experiments with 8 days' pre-treatment at 17·8° C., a germination of over 96% was possible even at 35° C.

Considering that the seeds germinated to over 96% within the temperature range of 17·8° C. to 27·8° C. without pre-treatment, it is evident that within this temperature range both the stages A and B could be completed simultaneously. At such temperatures, therefore, there is no possibility of recognising the two stages. This probably is the reason why the two stages in germination have escaped attention in other species. A fuller account of the experiments will be published elsewhere.

Our thanks are due to Dr. N. R. Bhat, Director, Tobacco Research, Central Tobacco Research Institute, Rajahmundry, for his kind interest in this work.

Central Tobacco Res. Inst., Rajahmundry, *July* 26, 1957.

N. L. Pal.
N. C. Gopalachari.

1. Johnson, J., Murwin, H. F. and Ogden, W. B., *Wis. Agr. Expt. Sta. Bull.*, 1930, **104**, 1–15.
2. Kincaid, R. R., *Fl. Agr. Expt. Sta. Bull.*, 1935, **277**, 1–47.
3. Crocker, W. and Barton, L. V., *Physiology of Seeds* (Chronica Botanica Co., Waltham, 1953).
4. Barton, L. V. and Crocker, W., *Twenty Years of Seed Research* (London, 1948).
5. Toole, E. H., *et al.*, *Ann., Rev. Plant Physiol.*, 1956, **7**, 299–319.
6. Barton, L. V., *Boyce Thos. Inst. Prof. Paper*, 1933, **26**, 248–50.

INFLUENCE OF CERTAIN SPECIES OF EARTHWORMS ON THE STRUCTURE OF SOME HILL SOILS

Certain species of earthworms in some soils of Himachal Pradesh have been found to affect the soil structure adversely. The earthworms form small castings into lumps which on drying become cement-like hard clods. Within a few years of infestation, the entire fertile soil having good structure becomes cloddy, structureless and unproductive. Many acres of land thus has lost its productivity.

The earthworms are pinkish to brown in colour and have small segments. Their size varies from 1" to 6" and they are very active. Their activities are confined to about 15" of the top soil and during unfavourable conditions they hibernate in the subsurface soil. As many as 250 worms per square foot of soil have been counted in the average infested lands.

Living and dead specimens of the worms were sent for identification to the Director, Zoological Survey of India, Calcutta, who has reported the same to represent the genus *Allobophora* of the family *Lumbricidæ* (Order Oligochæta). Most of the worms belonging to the genus *Allobophora* are known to be largely distributed over England, Ireland and are generally reported to be found in the Arctic regions. They are the only earthworms capable of burrowing through snow and ice.

The worms prefer heavy, compact soil and flourish well on organic matter and manure prepared from pine-tree leaves. The infested soils are situated at elevations of 7,000′ to 8,000′ above sea-level and have cool summers with a monsoon rainfall of about 60". These soils remain under snow for 3 to 4 months in winter. Texture of these soils is silty clay to clay loam and their colour varies from pale brown to dark brown. The pH of these soils varies from 5·8 to 6·8.

Microscopic studies show that these worms excrete some colourless waxy fluid from their nymphridia. This waxy fluid adheres to the soil particles and castings and it makes a gelatin-like membrane around them. This colourless waxy fluid perhaps functions as the cementing material to the castings and thus hard clods are formed.

Further work on this as well as remedies for rectification of the defects is in progress and will be reported separately.

Deptt. of Agriculture, Himachal Pradesh, Simla, *January* 4, 1958.

G. S. Agarwal.
K. S. K. Rao.
L. S. Negi.

1. Barret, T. J., *Harnessing the Earthworms* (Faber & Faber, New York).
2. Day, G. M., *Soil Science*, 1950, **69**, 175–84.
3. Dawson, R. C., *Soil Science Society of America Proc.*, 1947, **12**, 512–16.
4. *Encyclopædia Columbia*, **2**, pp. 583.
5. *Encyclopædia*, Britannica, **1**, pp. 994–95.
6. Quastel, J. H., *Soil Science*, 1952, **73**, 419–25.
7. Russel, E. J., *Journal of Agricultural Science*, 1910, **2**, 245–57.

ON THE OCCURRENCE AND LIFE-CYCLE OF THE JAK WEEVIL (*OCHYROMERA ARTOCARPI*, MARSHALL) AT COIMBATORE

THE Jak weevil *Ochyromera artocarpi*, Marshall has been so far reported from North Malabar and Mysore only (Ramakrishna Ayyar, 1932, 1940). Recently, during November 1957, this weevil was noted for the first time occurring in large numbers on jak (*Artocarpus heterophyllus*, Lamk.) growing in the gardens attached to the Agricultural College and Research Institute, Coimbatore. The grubs of the weevil were found boring the inflorescence with the result a large number of them dropped down. All stages were present inside the fallen buds. Since no information is available on the life-history and habits of the weevil, a study was undertaken during the month of December 1957 in the cold season when the average maximum and minimum temperatures were 83·4° F. and 67·0° F. respectively and observations are presented below in brief.

The adult is a small, active, greyish brown weevil measuring 3·5 mm. in length and 1·5 mm. in breadth, with the whole body thinly clothed with fine setiform golden scales and set with suberect setæ and elytra bearing numerous irregular and ill-defined small bare spots. It is often found in groups feeding on the tissue of inflorescence. Eggs are laid singly in small cavities excavated by the adults in the inflorescence. The egg is pearly white, smooth and oblong oval measuring on an average 0·42 mm. in length and 0·28 mm. in width. The eggs hatch in 3 to 4 days and the newly hatched

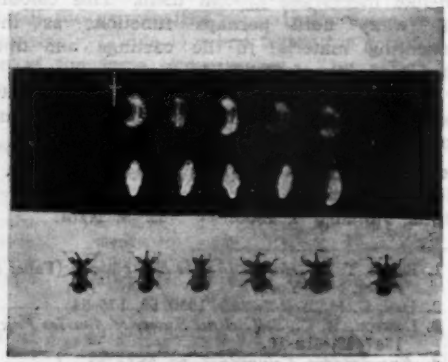


FIG. 1. Stages of Jak weevil (*Ochyromera artocarpi*, M.).

legless grub is pale white with a pale brown head and measures 0·56 mm. in length. It bores through the tissue in all directions and becomes mature in 12 to 15 days. The full-grown grub is whitish in colour measuring 4·9 mm. in length. Its head is light brown but darker at the frontal region and much narrower than thorax and with a conspicuous dark line in the frons. The body is moderately curved, tapering towards the posterior region. Pupation takes place in a cavity at the end of the larval burrow. The pupa is naked, whitish in colour and is about 3·6 mm. long and 1·5 mm. broad with numerous setigerous tubercles on the body. The pupal stage lasts for 5 to 6 days. The adult emerges by boring a hole on the outer skin. The total life-cycle of 28 individuals ranged from 20 to 25 days. The longevity of the weevil was rather short under captivity which ranged from 6 to 23 days for females and 5 to 18 days for males. The egg-laying capacity also was poor in captivity and the number of eggs laid by 15 individuals varied from 18 to 38.

Entomology Section, T. R. SUBRAMANIAN.
Agric. College & Res. Inst.,
Coimbatore, *February* 1, 1958.

1. Ramakrishna Ayyar, T. V., *Bull. Mad. agric. Dep.*, 1932, 27, 48.
2 —, *Handbook of Economic Entomology for South India*, 1940, 319,—Suptd., Govt. Press, Madras.

ROOT-KNOT NEMATODES ON POTATOES IN INDIA

SURVEY carried out in the principal potato-growing regions in the country has shown that root-knot nematodes (*Meloidogyne* spp.) are common pests of potatoes, with a wide host range. The disease caused by root-knot nematodes is not easy to recognise in the field as, very often, no symptoms above-ground are visible. Sometimes, however, severely attacked plants are stunted and may even show signs of premature wilting.[3]

In this country the species of *Meloidogyne*, attacking potato tubers, have been found to occur in over a wide area, and pathogenic species, inciting gall-formation on potato, have been collected from the following tracts:

Other susceptible plants recognised under conditions prevailing in the plains are *Lycopersicon esculentum*, *Brassica oleracea*, *Solanum nigrum*, *Solanum melongena*, *Achyranthus aspera*, *Ruellia* sp., *Coleus perviflorus*, *Physalis minima* and *Chenopodium album*.

Root-knot nematodes found in the plains on wild susceptible plants can, under favourable

	Location	Altitude above sea-level	Species involved
1	Uttar Pradesh (Almora and Bhowali areas) ..	4,000 to 6,000 ft.	*M. javanica* (Treub) Chitwood *M. incognita acrita* Chitwood
2	Simla Hills (covering regions around Theog-Mashobra valley)	5,500 to 6,500 ft.	*M. incognita acrita*
3	Bihar (Chotanagpur, hill regions of Ranchi and Netarhat)	2,500 to 3,700 ft.	*M. incognita* (Kofoid and White) Chitwood
4	Assam (throughout Shillong Hills)	5,000 to 6,000 ft.	*M. incognita*
5	Mysore (Chickballapur)	About 3,000 ft.	*M. javanica*; *M. incognita acrita*

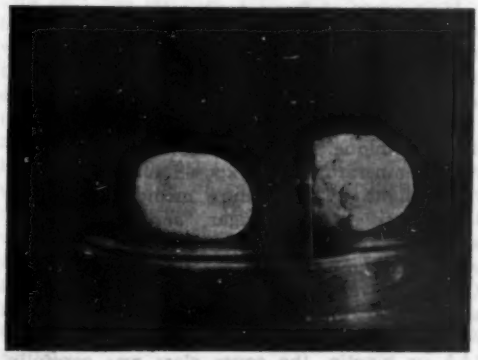
conditions, act as collateral hosts for the potato tuber infection. One of these is 'Kurkon' (*Coleus perviflorus*) which shows heavy gall-formation on roots infested with *M. incognita* (Fig. 2). In

b *a*

FIG. 1. (*a*) 'Kurkon' roots showing heavy gall-formation as a result of infestation with *M. incognita*.

(*b*) Normal roots of 'Kurkon'.

an experiment, 48 healthy plants of Up-to-date variety of potato were raised in pots containing sterile soil. They were divided into three sets of 16 plants each. To the first set, leachings of roots from 'Kurkon' infested with root-knot nematodes were added. To the second set of sixteen pots leachings from infested potato tubers carrying *M. incognita* on *Satha* variety secured from Ranchi were added. The third set served as control. All the pots were kept in a cool situation under shade. Sixty days after inoculation the tubers produced from all the plants grown on nematode inoculum derived either from *Coleus* roots and from the potato tubers showed typical root-knot symptoms (Fig. 1) whereas the control was completely free from infestation (Fig. 1).



b *a*

FIG. 2. (*a*) Potato tuber infected with root-knot nematode derived from 'Kurkon' roots.

(*b*) Control—normal potato tuber.

Earlier reports in this country of *Heterodera marioni* (Cornu) Goodey[2] being associated with gall-formation on potato should now be regarded as being caused by *Meloidogyne* sps.

We are grateful to Drs. M. T. Franklin and J. B. Goodey of Rothamsted Experimental Station, Harpenden, Hertfordshire, England, who have helped to identify the root-knot nematodes found associated with several plants.

Central Potato Res. Institute, Simla, *January* 17, 1958.

PUSHKARNATH.
B. N. ROY CHOUDHARY.

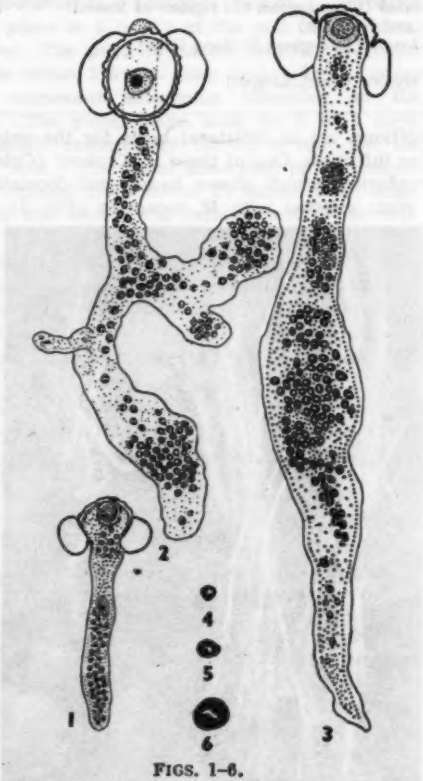
1. Steiner, G., 'Plant nematodes the grower should know," *Dept. Agric. Florida. Bull.*, 1953, **131**, 48.
2. Thirumalachar, M. J., "Root-knot nematodes of potato tubers in Simla," *Curr. Sci.*, 1951, **20**, 104.
3. Walker, J. C., *Root-knot Disease of Potato in Diseases of Vegetable Crops*, McGraw Hill, 1952, p. 370.

EFFECT OF IAA AND KINETIN ON POLLEN TUBES OF *PINUS ROXBURGHII* SAR.

EVER since 1834, when von Mohl (see O'Kelley, 1955) first noticed the germination of pollen grains in moist air, several attempts have been made to culture them artificially. It has been observed that pollens differ considerably in their power to germinate *in vitro*. However, in most cases the percentage of germination is lower and the length of the pollen tube considerably shorter than what is obtained under natural conditions. While sucrose is the principal component of the medium, germination and tube growth can be improved by incorporating boric acid, hormones and vitamins. Besides, in a number of cases, the use of plant tissue extracts has also given very favourable results.

Male cones of *Pinus roxburghii* were obtained from the plants growing near Vijay Chowk, New Delhi. The mature pollen showed two degenerated prothallial cells, the tube nucleus and the generative cell.

Pollen grains were cultured by the hanging drop technique. The cultures were stored at room temperature and exposed to diffuse laboratory light. The* culture medium comprised 15% sucrose, 0·66% agar, and 0·01% boric acid. This will be referred to hereafter as the basic medium. In some cases indoleacetic acid (2·5 p.p.m.) and in others kinetin (0·01%) was added after the pollen grains had grown for 3 days on the basic medium. For treating with IAA or kinetin, the cover glass was carefully removed, a drop of the chemical added with the help of a camel hair brush and the cover glass immediately replaced. After the pollen tubes had ceased to elongate, the coverglass with the agar film was removed and dried in the air, fixed in F.A.A., stained in acetocarmine and dehydrated in the tertiary-butyl alcohol-xylol series. The percentage of germination was determined by counting more than 100 grains from five or more different fields of the microscope. The tube length given is the average of 20 tubes. All readings were taken under the high power of the microscope after 8 days growth. Pollen grains cultured in sucrose-agar medium showed very little growth. To overcome this difficulty, 0·01% boric acid was added to the sucrose-agar medium. In this medium germination took place after about 48 hours. The percentage of germination varied from 78 to 82 and the average tube length was 203 μ (Figs. 1, 7). In IAA medium 80% of the pollen grains germinated and showed 490 μ long tubes (Figs. 2, 7). Although in the kinetin medium the length of the pollen tube increased to 586 μ (Figs. 3, 7), the germination was only 74%.



FIGS. 1–6.

Fig. 1. Germinated pollen grain in basic medium, × 560. Fig. 2. Same, in basic medium + IAA, × 560. Fig. 3. Same, in basic medium + kinetin, × 560. FIGS. 4-6. Relative sizes of the starch grains in the basic medium; basic + IAA; and basic + kinetin, × 1,070.

No branching or swelling of the tip of the pollen tube occurred in the basic medium and the tubes followed a straight course. However, when IAA was added there was profuse branching. In kinetin, on the other hand, branching was scarce but there was general swelling of the pollen tubes. Division of the antheridial cell was not induced by these chemicals. No relation could be seen between the branching of the tube and the position of the tube nucleus as recently reported by Tanaka (1956) in *Pinus densiflora*.

* All chemicals used were of the analytical reagent (AR) grade. Pyrex double distilled water was used throughout.

At the beginning of the experiment, no appreciable quantity of starch could be seen either in the pollen tube or in the pollen grains. In the basic medium starch was seen in the pollen grain as well as the tube but the amount is small and the grain size does not exceed 3μ (Fig. 4) in diameter; the cytoplasm is more or less uniform and without much vacuolation. In the IAA medium most of the starch is concentrated around the tube nucleus and at the tip of the pollen tube; the diameter of the starch grains is about 5·2μ (Fig. 5) and the latter have a prominent hilum. In kinetin the grain size is 7μ in diameter (Fig. 6). In both IAA and kinetin media the cytoplasm was scanty and vacuolated.

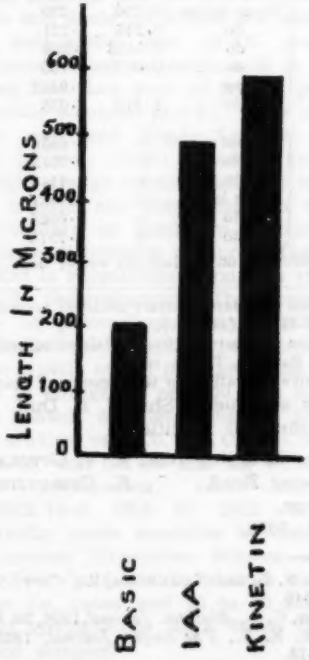


Fig. 7. Histogram indicating pollen tube length in microns in the basic medium; basic medium + IAA (2·5 p.p.m); and basic medium + kinetin (0·01%).

As is well known, the pollen tubes of *Pinus* remain in the resting condition in the nucellus for about 9 months. It is hard to believe that they survive this long period by utilizing only the stored food unless it is agreed that they also absorb and utilize food from the nucellar tissue. Since the time of Schleiden (1849) and Van Tieghem (1869; see Brink, 1924), several attempts have been made to culture the pollens of different plants in sugar solutions. In the angiosperms the reserve food material of the pollen grains may be sufficient in some cases to support an appreciable amount of growth. But in conifers like *Pinus* an intake of food material is essential as about 3 months elapse from the time the pollen tube resumes growth to the time of fertilization. Mangin (1866; see Brink, 1924) first noted that the pollen grains of some species, when placed in sugar solution, accumulate starch freely. Confirmation of this also came from Tischler (1917; see Brink, 1924). In *Pinus laricio*, Dodel Port (1880, see Brink, 1924) reported that on a concentrated sugar solution the pollen tube shows an accumulation of starch. From these observations it may be concluded that sucrose is taken up and converted into starch. *In vivo* also pollen tubes in the nucellus show a good accumulation of starch. This fact has recently been further confirmed by the work of Hellmers and Machlis (1956) who have shown, both qualitatively and quantitatively, that the pollen tubes of *Pinus ponderosa* absorb and utilise carbohydrates present in the culture medium. O'Kelley (1955, 1957) has also demonstrated, by the use of C^{14}-labelled sugars, that sugars are absorbed and used in the respiration of germinating pollen tubes of *Tecoma radicans*. The greater accumulation of starch in the pollen tubes of *Pinus roxburghii* when supplied with kinetin and IAA suggests that these chemicals probably enable the pollen tubes to absorb larger quantities of sugars from the medium and convert it to starch.

I am greatly indebted to Prof. P. Maheshwari under whose guidance this work was carried out. My thanks are also due to Mr. I. K. Vasil who helped me in the pollen culture work.

Botany Department, R. N. KONAR.
University of Delhi,
February 14, 1958.

1. Brink, R. A., "The physiology of pollen, II", *American J. Bot.*, 1924, **11**, 283–94.
2. Hellmers, H. and Machlis, L., "Exogenous substrate utilization and fermentation by the pollen of *Pinus ponderosa*," *Plant Physiol.*, 1956, **31**, 284–89.
3. O'Kelley, J. C., "External carbohydrates in growth and respiration of pollen tubes *in vitro*," *American J. Bot.*, 1955, **42**, 322–27.
4. —, "Boron effect on growth, oxygen uptake and sugar absorption by germinating pollen," *Ibid.*, 1957, **44**, 239–44.
5. Tanaka, K., "The pollen germination and pollen tube development in *Pinus densiflora* Sieb. et Zucc, II. The tube growth and tube nucleus," *Sci. Rep. Tohoku Univ.*, 1956, **22**, 219–24.
6. Schleiden, M. J., *Principles of Scientific Botany* (*Trans.*), London, 1849.

NOTE ON THE ESTIMATION OF STARCH IN SUGARCANE

QUALITATIVE examination for starch of different species of *Saccharum* and allied genera at this Institute[1] has shown that fairly large quantities of starch are found in them. For the quantitative determination of starch in sugarcane, the β-amylase method as used by Hanes[2] was successfully employed and has been in use at this Institute for quite a long time. Balch[3] and Alexander[4] have recently reported colorimetric method for the determination of starch content in cane juices. An examination of the efficacy of the two methods revealed certain characteristic differences which are reported in this note.

The starting material for the determination of starch in both the methods is the residue left after the sugars are thoroughly extracted with 85% alcohol. Using 1 g. of sugar-free residue, starch extracts were prepared with neutral calcium chloride according to the method of Balch (*loc. cit.*) and by solubilisation with alcoholic hydrochloric acid and hot water extraction as adopted by Hanes.

Using suitable aliquots of the two extracts, the amount of starch present in them was determined according to Balch in a Hilger photo-electric colorimeter, A. R. soluble starch being used as standard. Simultaneously, a 25 c.c. aliquot of starch extract obtained according to Hanes was treated with 2 c.c. of acetate buffer and 2 c.c. of β-amylase and the reducing power of the hydrolysate was determined in terms of maltose using Somogyi[5] reagent recommended for maltose estimation.

The results obtained by the colorimetric method and the enzyme hydrolysis method are given in Table I. It can be seen from the table that in general the values obtained by the colorimetric method are definitely lower than those obtained by the β-amylase method. At higher concentrations, however, the differences between the values obtained by the two methods were less marked though the values obtained by the colorimetric method are relatively low. It is also observed that at lower concentrations of starch, for example, as in the case of Co. 419 (Table I) the chromogen formed (according to Balch) was very feeble and as such its intensity could not be measured. At higher concentrations, on the other hand, the variation in the values of the two methods was much less. For the estimation of starch in sugarcane, therefore, the enzyme hydrolysis method of Hanes is found more suitable.

TABLE I

Table showing the comparison between the colorimetric method and the β-amylase hydrolysis method

Variety	Description of sample	Solution A*		Solution B*
		Colorimetric method	Enzyme hydrolysis method	Colorimetric method
Erianthus	Bottom stem	3·010	3·692	2·940
	do	..	3·578	2·557
	do	3·855	4·160	4·066
	do	4·65	4·522	4·566
	do	1·80	2·975	1·660
	do	2·95	3·658	3·100
Katha	Green leaves	0·256	1·239	0·4375
	do	0·248	1·221	0·4175
	do	0·5558	1·368	0·6581
	do	0·6670	1·709	1·180
	do	..	0·9572	0·295
	do	1·215	2·033	1·450
Co. 419	Bottom stem	+	0·6836	+
	do	+	0·7519	+
	do	+	0·4443	+
	Green leaves	+	0·7861	+
	do	+	0·6665	+
	do	+	0·7578	+

(All percentages on residual dry weight basis.)

* *Solution A*—Starch extract obtained according to the method of Hanes (*loc. cit.*).

* *Solution B*—Starch extract obtained according to the method of Balch R. T. (*loc. cit*).

\+ Positive indication for the presence of starch.

Thanks are due to Shri N. L. Dutt, Director, for affording all facilities.

Sugarcane Breeding Inst., K. V. GOPALA AIYAR.
Post Lawley Road, K. CHIRANJIVI RAO.
Coimbatore,
March 3, 1958.

1. Dutt, N. L. and Narasimhan, R., *Curr. Sci.*, 1949, **9**, 346.
2. Hanes, C. S., *Biochem. Journal*, 1936, **30**, Pt. 1, 168.
3. Balch, R. T., *The Sugar Journal*, 1953, **15**, (8), 11–15.
4. Alexander, J. B., *South Afri. Sug. Jour.*, Sept. 1954.
5. Somogyi, M., *J. Biol. Chem.*, 1945, **10**, 61.

ON THE PHENOLIC CONTENT OF SUGARCANE AND SPONTANEUM JUICES

PHENOLS in sugarcane juice are mainly tannin and anthocyanin of the rind. These are referred to as polyphenols. The quantitative study of phenols in cane juices has not so far received much attention. Colorimetric methods are generally found more suitable for estimat-

ing phenols in plant fluids. The Folin-Denis[1] colorimetric method is not found satisfactory for cane juices as appreciable amounts of non-phenolic reducing substances including glucose[2,3] interfere with the colour development. The diazotised sulphanilic acid reagent of Fox and Gange[4] as used by Miller and Urbain[5] for estimating phenols in water was found most satisfactory for the direct determination of phenols including cane tannin in raw cane juices. The procedure of estimation and some preliminary data on the phenolic content of the juices of a few cultivated Co. canes and wild spontaneums are reported in this paper.

Centrifuged fresh cane juice—3 to 5 ml. is made upto 100 ml. 5 ml. of this solution is freed from proteins and the filtrate made upto 50 ml. To this made up filtrate are added first 4 ml. of sulphanilic acid (0·8% containing 1 ml. of concentrated sulphuric acid in 250 ml. of solution) and then 2 ml. of freshly prepared sodium nitrite solution (8·0%). The contents are mixed well and finally 5 ml. of sodium hydroxide solution (10%) is added and mixed. The light orange colour is allowed to develop for 3 minutes and then compared with an artificial standard of potassium permanganate and potassium dichromate mixture. The artificial standard is standardised against a standard solution of phloroglucinol. The weight in milligrams of phloroglucinol representing the phenolic content per 100 ml. of juice divided by the specific gravity of the juice gives the weight of phenols in milligrams per 100 g. of juice.

Phenolic content was determined in juices of six cane varieties, *viz.*, Co. 285, Co. 290, Co. 419, Co. 421, Co. 439 and Co. 467 and six varieties of *Saccharum spontaneum*, *viz.*, Imp. 1182, S.H. 328, SES. 74-A, SES 45, SES. 327 and SES. 532 kindly made available by the Botanist, Spontaneum Expedition Scheme of this Institute. Four to five fully mature canes in the case of Co. canes and 30 to 40 stalks in the case of spontaneums were taken for obtaining juice samples.

In Table I are given the amounts in milligrams of phenolic substances (in terms of phloroglucinol) on juice weight basis.

It is evident from the data that on the whole the phenolic content of spontaneum juices is higher than that of cultivated canes. Co. 285 shows the highest phenolic content—mean value 102 mg. as compared to the other five varieties where the mean value ranges between 28 mg. and 58 mg. On the other hand, the mean phenolic content of spontaneums ranges between 70 and 139 mg.

TABLE I

Amount in milligrams of phenols expressed as phloroglucinol per 100 g. of juice

Variety	D_1		D_2		Mean
	L_1	L_2	L_1	L_2	
Co. canes					
Co. 285 ..	109	108	102	90	102
Co. 421 ..	56	58	58	60	58
Co. 467 ..	56	55	49	..	53
Co. 419 ..	45	45	45	47	46
Co. 290 ..	35	34	35	32	34
Co. 439 ..	28	30	26	..	28
Spontaneums					
Imp. 1182 ..	129	132	153	140	139
SES. 74-A ..	104	100	110	110	106
S. H. 328 ..	106	108	95	98	102
SES. 45 ..	106	103	104	91	101
SES. 327 ..	71	72	72	66	70
SES. 532 ..	46	44	44	..	45

Using 2 dilutions D_1, D_2 for each juice and two levels L_1, L_2 for each dilution and 4 to 6 readings taken in 3 minutes per dilution.

except SES. 532 which contains only 45 mg. The higher phenolic content in spontaneums and Co. 285 is very characteristic and may be of special physiological significance in the hardy and disease-resistant character of these varieties.

Full details of this work will be published elsewhere. Thanks are due to Shri S. Ramakrishnan, Junior Assistant, for assistance and to Shri N. L. Dutt, Director, for kindly affording facilities.

Sugarcane Breeding Inst., K. PARTHASARATHI.
Post Lawley Road, M. VIJAYASARADHY.
Coimbatore, *March* 3, 1958.

1. Folin, O. and Denis. W., *J. Biol. Chem.*, 1915, **22** 305.
2. Scheiner, E., *Biochem. Z.*, 1929, **205**, 245.
3. Hidekatsu Fujiwara and Eiseikatsuoka, *Z. Physiol. Chem.*, 1933, **216**, 135.
4. Fox, J. J. and Gange, A. J. H., *J. Soc. Chem. Ind.*, 1920, **39**, 269, T.
5. Miller, J. N. and Urbain, O. M., *Ind. Eng. Chem. Anal. Ed.*, 1930, **2**, 123.

RESPONSE TO TOUCH STIMULI BY A TENEBRIONID BEETLE, *GONOCEPHALUM DEPRESSUM* K.

A STATE of immobility or death-feigning in response to a sudden and brief stimulus is a known fact in many insects. Such state has been termed thanatosis. Roeder[2] has used the term catalepsy to cover both thanatosis and protective pose. The present note deals with a study of thanatosis in *Gonocephalum depres-*

sum K. in response to touch stimuli applied with needle and with thread. Besides, stimuli were applied to the different regions of the body to compare the sensitivity of the regions to touch stimuli.

Before application of a stimulus each insect was kept confined to a filter-paper with an inverted funnel for a few hours (4-6 hours). Thus each insect was given a long period of quiet in order to avoid holding or pressing or any other stimulation during application of stimuli. Picking or pressing or dropping has earlier been observed[3-5] to influence the duration of death-feigning of some insects. The period of thanatosis shown by each individual insect was noted with the help of a stop-watch.

No significant difference has been observed between the responses shown by *G. depressum* to the two different stimuli. Stimuli with thread were not applied to the coxa due to some unavoidable reasons. Responses to stimuli applied with needle to the different regions of the body have been compared. The period of thanatosis in response to touch stimuli to the different regions of the body studied is generally short except that in response to stimuli applied to the coxal segments of legs (Fig. 1),

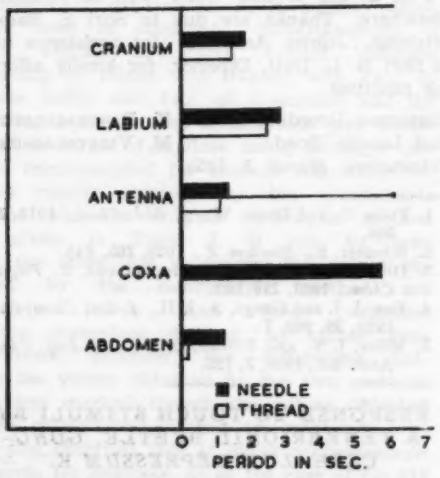


FIG. 1. Response of *Gonocephalum depressum* to stimuli applied with needle or thread to the different regions of the body.

which appear to be the most excitable regions. A longer period of thanatosis was observed when the antennæ were amputated (see Fig. 1, response represented by narrow line against antenna). Rabaud[1] induced tonic immobility by decapitating a number of Lepidoptera which did not show such response to feeble stimulation. Thanatosis is probably induced more effectively by a stronger stimulus in insects which show little or no thanatosis to a lighter stimulus.

The authors are thankful to Dr. A. P. Kapur, Entolology Section, Zoological Survey of India, who kindly identified the species.

Dept. of Zoology, Birla College, Pilani, *May* 15, 1957.

A. K. DATTA GUPTA.
B. B. GUPTA.

1. Rabaud, E., *Bull. Soc. Zool. Fr.*, 1917, **42**, 158-66.
2. Roeder, K., *Insect Physiology*, 1953, 483-85.
3. Weiss, H. B., *J.N.Y. ent. Soc.*, 1944, **52**, 281-83.
4. —, *Ibid.*, 1947, **55**, 275.
5. —, *Ibid.*, 1951, **59**, 245.

COBALT AND ZINC CONTENTS OF A FEW FORAGE PLANTS OF WESTERN INDIA

THOUGH the exact role of cobalt and zinc in plant nutrition is yet to be confirmed, their importance in animal nutrition is well established. While cobalt is a constituent of vitamin B_{12}, zinc has been found to be essential in the utilization of vitamin A, riboflavin, biotin, pantothenic acid and other essential fatty acids. Forage plants are the only source of Co and Zn for livestock requirements. Plants growing on normal soils rarely suffer from zinc deficiency and even under the most deficient conditions in soils, Zn concentration of pasture plants rarely falls below 10 p.p.m.[5] which is enough to meet animal requirements. Cobalt deficiencies, on the other hand, are of more common occurrence and pastures containing less than 0·07 p.p.m. Co induce such diseases as bush sickness, phalaris staggers, salt sickness and other wasting diseases leading to death.[1,3] As information is lacking on the Co and Zn contents of forage plants of Western India, a preliminary survey was carried out to determine the Co and Zn status of important forage plants from the grasslands of Bombay. All plant samples were collected at the flowering stage and the analysis was made on triplicate samples by the methods of Piper.[4]

Table I shows that the Co content of grasses varies from 0·2 to 1·0 p.p.m. with an average of 0·6 p.p.m. while the Zn content varies from 10·73 to 36·19 p.p.m. with an average of 16·93 p.p.m. The legumes, on the other hand, contain slightly higher amounts of Co varying from 0·4 to 1·6 p.p.m. with an average of 0·8 p.p.m. but lesser amounts of Zn, varying

TABLE I

Average Co and Zn contents of some Indian forage plants
(p.p.m. of dry matter)

	Botanical Name	Co	Zn
1	*Ischæmum ciliare* Retz.	0·4	36·19
2	*Heteropogon contortus* L.	0·6	14·04
3	*Themeda triandra* Forsk.	0·8	12·01
4	*Themeda quadrivalvis* OK.	0·7	14·14
5	*Pseudenthistiria heteroclita* Hk.	0·8	13·57
6	*Arundinella tenella* Lawii	1·0	10·73
7	*Dicanthium annulatum* Stapf.	0·3	12·54
8	*Eulalia fimbriata* Bl. & Mc.	0·2	20·21
9	*Indigofera tinctoria* L.	1·6	8·73
10	*Heylandia latebrosa* DC.	1·2	4·99
11	*Crotolaria linifolia* L.	0·4	13·42
12	*Crotolaria triquetra* Dalz.	0·4	18·41
13	*Crotolaria filipes* Benth.	0·5	16·38
14	*Smithia sensitiva* Ait.	0·8	6·71
15	*Alysicarpus vaginalis* DC.	0·7	5·48
16	*Alysicarpus pubescens* Law.	0·6	4·60

from 4·60 to 18·41 p.p.m. with an average of 9·84 p.p.m. Our Co values confirm the findings of Datta and Datta Biswas[2] who found 0·10 to 0·60 p.p.m. Co in the young stages of some Indian fodder plants grown under uniform conditions in pot cultures. While there appears to be no deficiency of Co in the pasture species of Western India, the probability of Zn deficiency arising in the mature stages cannot be ruled out, as the Zn content is in marginal amounts in grasses with the exception of *Ischæmum* and *Eulalia* and in deficient amounts in the legumes, excluding species of *Crotolaria*. As soil analysis has shown that the available Zn content of the grassland soils is uniform, plant intake of Zn appears to be more dependent on species than on available Zn. Since the mineral content of pasture plants decreases with age, there is a likelihood of Zn deficiency occurring even in grasses. Therefore, stock requirements of Zn can be met with only if the forage is harvested just after flowering.

Dept. of Botany, (MISS) JAYA G. IYER.
Institute of Science, Y. SATYANARAYAN.
Bombay-1, *December* 23, 1957.

1. Askew, H. O., *New Zealand J. Sci. and Technol.*, 1939, **20 A**, 315.
2. Datta, N. P. and Datta Biswas, N. R., *Indian J. Agric. Sci.*, 1950, **21**, 93.
3. Mitchell, R. L., *Soil Sci.*, 1945, **60**, 63.
4. Piper, C. S., "Soil and Plant Analysis," *Waite Agric. Res. Inst.*, 1944.
5. Underwood, E. J., *Trace Elements in Human and Animal Nutrition*, 1956, Academic Press.

DETECTION OF MUSTARD OIL IN OTHER EDIBLE OILS

CASES have been encountered where mustard oil was used to adulterate other edible oils. Suspicion would arise from the trend of the usual analytical characteristics. The following test has been devised to confirm the presence of mustard oil; it is based on the detection and estimation of allyl iso-thiocyanate, the volatile constituent present in mustard but not in other edible oils.

The A.O.A.C. method[1] for the determination of volatile oil of mustard was followed with slight modification. In brief the method consists in mixing 10 ml. of the oil with 100 ml. of water for 2 hours, and then adding 20 ml. of alcohol. The mixture is distilled, and 60 ml. of distillate is collected in a flask containing 10 ml. of dilute ammonia (1 : 2). Twenty ml. of N/10 $AgNO_3$ are added to the distillate, and after standing overnight to coagulate Ag_2S, the solution is made up to 100 ml., and filtered. Fifty ml. of filtrate are distinctly acidified with HNO_3 and titrated with N/10 NH_4CNS using 5 ml. of 10% ferric ammonium sulphate as indicator.

1 ml. N/10 $AgNO_3 = 0·004956$ g. allyl iso-thiocyanate.

An indication of the presence of mustard oil is obtained even during addition of $AgNO_3$ solution to the distillate, by immediate formation of a dark colour and black precipitate. With other oils, only a slight brown colour may at worst develop on standing overnight. The intensity of the dark colour and the amount of black precipitate formed are directly related to the amount of mustard oil present.

Some results are summarized in Table I.

TABLE I

	Allyl iso-thiocyanate
Mustard oil No. 1	Present (0·38% appx.)
Do. No. 2	do (0·19% appx.)
Linseed oil	Nil
Niger seed oil	do
Cocoanut oil	do
Groundnut oil	do
Sesame oil	do
Linseed oil containing mustard oil No. 1	Present (0·05% appx.)
Do. No. 2	Present (0·01% appx.)

Work is in progress on the detection of the sulphur in the volatiles of mustard oil by conversion to H_2S by a simple method.

Central Food Lab., S. N. MITRA.
Calcutta-16, B. R. ROY.
March 4, 1958. P. N. SENGUPTA.

1. *Official and Tentative Methods of the Association of Official Agricultural Chemists*, 8th Ed., 1955, p. 517.

REVIEWS

Solid State Physics. (*Advances in Research and Applications*, Vol. 3.) Editors: F. Seitz and D. Turnbull. (Academic Press, Inc., New York.) Pp. 588. Price $12.00.

This is the third volume of the series and it contains six excellent articles on some of the vital problems of Solid State Physics. In reviewing such a book one has to rest content with enumerating the articles and giving the barest summary of each. The topics dealt with are: (*i*) Group III-Group VI compounds, (*ii*) The continuum theory of lattice defects, (*iii*) Order-disorder phenomena in metals, (*iv*) Phase changes, (*v*) Relations between concentration and imperfection in crystalline solids, and (*vi*) Ferromagnetic domains.

To each article is appended an exhaustive list of references which alone would have completely justified the publication of this volume.

It has long been realised that Group II-Group VI compounds like ZnS and Group I-Group VII compounds like CuI possess semiconducting properties. The important set of semiconducting Group III-Group V compounds like Ga-As, In-As, etc., have been investigated only recently and the first article in the book by H. Welker and H. Weiss deals with the physical and chemical properties of such compounds. The electrical, magnetic and optical properties have been dealt with in some detail.

The introduction of an interstitial or impurity atom, a vacant site or a dislocation, in general, alters the position of every lattice point and in many cases it is most satisfactory to treat the greater part of the crystal as a continuum. For this, one uses the usual theory of elasticity modified by the presence of internal stresses which have to be considered as being capable of moving about in the medium. Such treatments have been developed as early as 1897 by Burton and by Larmor when the elastic theory of ether was in vague. This method is found to be extremely useful in treating the modern problems of lattice defects. This has been dealt with in a clear and beautiful manner by J. D. Eshelby in such a way that the reader can grasp some of the important uses as also the disadvantages of this elegant technique.

The order-disorder phenomena in metals, particularly the means of detecting the short-range and long-range "order parameters" form the topic of the third article by L. Guttmann. Particularly valuable are the parts on the statistical thermodynamics of order of alloys and the kinetics of order-disorder transformation. The article concludes with a useful appendix on ideal ordered structures.

The fourth article on phase changes by D. Turnbull aims at elucidating the relative stability of different phases of the same substance and also presents the mechanism of formation of one phase in another. With this view the classical explanation of Gibbs is presented and it is followed by recent theories of phase stability and of the mechanism of phase change.

The next article by F. A. Kroger and H. J. Vink gives the different types of relationship between the concentrations of imperfections so that from such a knowledge one may hope to control and regulate the concentrations of the different imperfections. These authors make use of a novel graphical treatment (in preference to the analytical one) which makes the understanding of this rather complex subject very much easier and which facilitates in the appreciation of the pioneering ideas of Wagner and Schottky.

The last article by C. Kittel and J. K. Galt deals with the various aspects of the ferromagnetic domain theory.

One cannot but be impressed by the thoroughness with which the authors have presented each topic. The editors deserve special congratulations and thanks of all Solid State Physicists on having embarked on the publications of these indispensable volumes. S. R.

Introductory Nuclear Physics. (Asian Students Second Edition.) By David Halliday. (Publishers: Asia Publishing House, Bombay), 1957. Pp. ix + 493. Price Rs. 17.50.

This edition of the book, styled as Asian Students Edition, is much cheaper than the original, first published in 1950, so as to bring it within the purse of each and every student. Nuclear physics has gained much importance in recent years and many Universities offer this subject as a part of their curriculum. It is imperative, for any one who is pursuing the profession of a physicist to be acquainted with nuclear physics in order to keep himself in touch with this rapidly growing and important subject of fundamental interest. The need for

such contact with this subject is all the more important for the present-day generation of students of physics.

To fulfil this need, the book should start from elementary ideas and lead the reader on to the more advanced ideas on the subject. As the theoretical side of the subject is bound up with much of complicated mathematical apparatus, it would be bewildering to the student to give anything more than the necessary dosage of this. The experimental aspect of the subject should be stressed and only such theoretical ideas that would be helpful in understanding the significance of the experiments should be introduced. In the present book, such a line has been adopted and a compromising synthesis has been brought out. Its experimental bias makes it the ideal one for the non-specialists to appreciate and understand the subject. The treatment covers all the major topics including such aspects as fundamental particle physics, cosmic rays, nuclear spin and magnetism, electric quodropole moments, nuclear fission and nuclear reactions. Thirteen appendices elaborate certain points of interest at the end.

It is a book which in the opinion of the reviewer can be warmly recommended to persons who are non-specialists in the subject, but who want to understand something of this complex subject.

Neutron Cross Sections. By Donald J. Hughes. (International Series of Monographs on Nuclear Energy, Division II, Volume I.) (Pergamon Press, London, New York, Paris), 1957. Pp. 182. Price 30 *sh.*

This monograph is essentially meant for those non-specialists in nuclear physics, who still intend to interpret and use the available experimental data on neutron cross-sections, as compiled and published by the Brookhaven National Laboratory and others.

Any intelligent understanding and use of such data is considerably complicated by the great variety of the observed neutron cross-sections and their rather unsystematic nomenclature. The available experimental data on neutron cross-sections is now so vast and the experimental techniques so various, that it is rather difficult to keep an overall picture of the present state of development of the subject. Chapter I removes both these difficulties quite satisfactorily.

A proper appreciation of the available experimental data requires that these neutron cross-sections must be related to the nuclear structure. However, the conceptual nuclear structure has been considerably modified by the recent successes of the nuclear optical model and the nuclear shell model. Chapter II quite simply deals with this situation in connection with neutron cross-sections.

The last four chapters deal with the specific techniques for measurement of neutron cross-sections and the nature of results obtained by them. Chapter III specifically deals with fast neutrons. Chapters IV and V deal with resonance neutrons interacting with non-fissionable and fissionable nuclei respectively. Chapter VI deals exclusively with the interactions produced by thermal neutrons.

This monograph is very clear, concise and easy to read. It is excellent as an introduction to this subject. It will certainly enable one, without prior specialisation in nuclear physics, to use intelligently the available experimental data on neutron cross-sections.

K. M. G.

Methods of Biochemical Analysis, Vol. V. Edited by David Glick. (Interscience Publishers, Inc., New York; India: Asia Publishing House, Bombay-1), 1957. Pp. ix + 502. Price $ 9.50.

This book which is the fifth volume of annual series on "Methods of Biochemical Analysis", comprising methods, procedures and techniques for the determination and assay of biologically important substances maintains the high standard set by the previous volumes. The editor states in the preface, "The general plan followed in the organisation of the individual chapters is a discussion of the background and previous work, a critical evaluation of the various approaches, and a presentation of the procedural details of the method or methods recommended by the author. The presentation of the experimental details is to be given in a manner that will furnish the laboratory worker with a complete information required to carry out the analysis". This aim has been amply achieved in this book.

The topics discussed relate to assay methods for choline esterases, biological standards in biochemical analysis, α-keto acid determinations, microdetermination of cobalt in biological materials. Activation analysis and its application in biochemistry, contamination of trace element analysis and its control, chemical determination of estrogens in human urine and infra-red analysis of vitamins, hormones and coenzymes. A cumulative index for Volumes I-V is provided in this volume.

In each case the treatment starts with introduction, general principles involved in the preparation of samples for analysis and the description of various methods and techniques employed in the determination. The reader can appreciate more clearly some of the difficulties involved in the problems and at the same time provide with useful practical information. The treatment of each topic by the author, who is a specialist, is simple and clear. The present volume achieves so useful a level of competence and value that no biochemist interested in the topics discussed in the volume should be without it. The book is well printed on good quality paper, is attractively bound and is free from printing errors. The editor and the authors are to be heartily congratulated upon the production of this volume, and the series constitutes a most notable contribution to biochemical analysis.

K. V. GIRI.

Sulphonamides—Second Conference. (*Annals of the New York Academy of Sciences*), Vol. 69, Art. 3, 1957. Pp. 377-564. Price $3.00.

This is a monograph on the sulphonamides comprising of 17 articles by 32 authors (predominantly American) including such authorities on the subject as G. Domagk, P. H. Long, D. Lehr, M. H. Lepper, M. Finland, M. Hamburger and A. M. Rutenburg. The first article is by Gerhard Domagk who was awarded the Nobel Prize in Medicine in 1938 for his discovery of the chemotherapeutic value of prontosil. In this article after summarizing the use the sulphonamides have been put to during the last quarter century, he gives reasons for the recent renewed interest in these antibacterial agents. This is followed by 8 articles on the value of the currently used sulphonamides in clinical practice, including an excellent one on the toxicity of these drugs by Lehr, wherein he restates his arguments for the use of sulphonamide mixtures. The rest of the publication (8 articles) deals with two new sulphonamides—Sulfachloropyridazine and Sulfamethoxypyridazine. These articles comprise of reports on therapeutic trials of these drugs both in experimental animals and in clinical cases of bacterial infection. The chief advantage of one of them (sulfamethoxypyridazine) over the current sulphonamides seems to be its prolonged action in the body by virtue of its slow elimination by the kidney (p. 450). This means that the drug could be given at longer intervals both in infections susceptible to sulphonamides (single daily dosage, p. 507), and in the prevention of steptococcal infections in rheumatic patients (once or twice a week, p. 491). There are some repetitions but this is inevitable in a publication of this type.

This is a timely publication when the newer antibiotics are overshadowing the sulphonamides and obscuring their real value. The sulphonamides are cheap (a consideration of great importance in this country) and are now relatively non-toxic. Clinicians, pharmacologists, and biochemists interested in the subject, will find it well worth their while to read this monograph.

S. C. DEVADATTA.

Rice in India. By R. L. M. Ghose, M. B. Ghatge and V. Subrahmanyan. (Indian Council of Agricultural Research, New Delhi.) Pp. x + 507. Price Rs. 21.

The Indian Council of Agricultural Research has an ambitious programme of bringing out a series of monographs on the various crops of India, and the present volume, the first in the series, deals with rice, the most important food crop of the country. The publication is a critical compendium of information on research work done in the country up to the end of 1956. The book has three parts dealing respectively with Agriculture, Marketing and Technology, and each of these parts has been handled by a most competent authority on the subject.

Part I, covering nearly three-fourths of the volume, deals with Agriculture and has 21 chapters, the first eight on general problems, the next nine on different aspects of research in the crop and the last four on the most important aspects of extension work. This part also has 5 Appendices giving valuable information on climatic conditions, list and distribution of various rice pests and diseases, green manuring practices and crops used for green manuring and an up-to-date list of improved strains evolved by breeding. The chapters on genetics and cytology are only brief summaries of work done on these subjects in India, but they make a substantial contribution to our present knowledge of them. The large chapter on Agronomy, in its restricted meaning, summarises the information on results of extensive experiments on manures and fertilisers conducted in the different States of India. Some information is also provided on the special features of nitrogen and phosphate utilisation in water-logged soils. The limited information on crop sampling, plant correlations, field plot

techniques, etc., that has come out mostly from work at the Central Rice Research Institute is also included. Chapters 7 and 8 in the general section deal respectively with diseases and pests and so also Chapters 16 and 17 in the Section dealing with research. The contents of the chapters differ and there is no repetition of information as the chapter headings would appear to indicate. Perhaps the contents of Chapters 7 and 8 could have been summarised and included along with Chapters 16 and 17. The Section on extension has four useful chapters dealing respectively with seed multiplication and distribution, production and distribution of fertilisers, organisation of plant protection and Japanese method of rice cultivation as adapted and practised in India.

Part II deals with Marketing of Rice in India and has ten chapters giving information on various aspects including protection, share of production coming for marketing, wholesale and retail prices, classification, grading and standardisation, etc. It is said that only 50-60% of the price paid by the consumer goes to the producer, and mention is made of the steps that are being taken to increase the share of the producer. It may be said that in no other rice-growing country of Asia, except perhaps Japan, such detailed information on rice marketing has been collected as in India.

Part III dealing with technology provides information on technology of rice processing, nutritive value of rice and rice diets and their nutritional improvement. Results of research done at the Central Food Technological Research Institute, Mysore, on preparation of nutritionally rich foods are included in this Part.

This is the first time an authoritative publication of scientific work done on an important agricultural crop has been made available to the public in India and elsewhere. The authors of the book have done a splendid job and research workers and students in India have now a valuable reference publication available to them. The book though it incorporates valuable research on certain aspects, information on other aspects is sketchy and needs more work. Investigations that should prove particularly valuable refer to the determination of linkage groups, the nutrition of the rice plant, the chemistry of water-logged soils and a better understanding of the soil-water-plant relationship. These studies are receiving greater attention in Japan and U.S.A.

The Indian Council of Agricultural Research can be congratulated on the excellent get-up of the publication with a number of charts and illustrations and it differs in this respect from some of their earlier publications. The larger volume of work devoted to rice and the availability of publications recording the results of such work has no doubt facilitated the preparation of this publication, and we may confidently look forward to similar books on other important crops. The value of the book would have been enhanced by a suitable index which is not there now, and we hope this defect will be remedied in the revision of the present edition which we understand is in progress as the first printing has already been sold out.

K. R.

Discovery Reports—Sperm Whales of the Azores. Vol. 28. By Robert Clarke. (Cambridge University Press, London, N.W. 1), 1956. Pp. 237-98. Price £ 27 6 *d.*

The report under review well illustrates the amount of data, the careful analysis and the cautious generalisations which lie behind each statement appearing in scientific text-books. For example, this entire report may be summarised in text-books as a short paragraph "The males live for 32 years and grow to a length of 59 ft. while females die after 22 years attaining a length of about 55 ft. Whales mature when they are 26-41 ft. long. Breeding is seasonal and young ones are born usually between July and August. The period of pregnancy extends to 16 months and the mothers nurse the young for 13 months. The female sexual cycle lasts about 3 years. The first teeth are cut when the young are about 21 ft. long; subsequent teeth may erupt in the middle of a row. The number of teeth may vary, independent of age. Females are usually in group whereas some males are solitary. During migration the males arrive first." But only when students read reports like the present, they will understand the wealth of observations and measurements and dry statistical analysis from which these facts are extracted.

C. P. G.

The Mango. By S. R. Gangolly, Ranjit Singh, S. L. Katyal and Daljit Singh. (Indian Council of Agricultural Research, New Delhi), 1957. Pp. xiii + 530. Price Rs. 40.

This illustrated monograph entitled *The Mango* constitutes a welcome addition to the relatively meagre literature available on this leading fruit of India. It presents the results of a descriptive study of the more important mango varieties of this country carried out under an I.C.A.R. scheme initiated in 1946.

The monograph is divided into two parts. Part I deals with the mango varieties. After a short introduction to the romantic legends associated with the occurrence, use and nomenclature of mangoes in India, the authors outline briefly a taxonomic description of the mango and the limited cytogenetical investigation carried out in relation to it. This is followed by detailed descriptions and coloured illustrations of 210 leading mango varieties selected from different parts of India. The authors have adopted the descriptive terminology and the methods of selection of specimens employed by Naik and Gangolly (1950) in their study of the South Indian mangoes. It is well known that in mango varieties the qualitative characters such as the shape of the fruit and leaves are relatively more constant than quantitative characters such as their size and weight which may vary under changing environments. This fact, coupled with absence of any adequate pedigree records in regard to most of the varieties, and the fanciful practice of giving arbitrarily different names to the same variety (or *vice versa*) in different localities, greatly complicates the problem of straightening out the present chaos that prevails in the matter of taxonomy and nomenclature of the mango varieties of this country. The present monograph serves more to underline this problem rather than solve it. The lack of a comparative key to the identification of the different varieties considered here impairs the practical utility of this monograph beyond confirming the identity of a known variety by comparison with the given description, data and the coloured illustration. The coloured illustrations, however, are often unnatural in regard to hue, there being a predominance of orange colour in almost all the mangoes illustrated.

Part II of this Monograph outlines the techniques and problems of mango cultivation, giving information of practical interest to growers. In the first chapter, after a brief reference to the distribution and acreage under mango cultivation in the various parts of India, and the climate and soil conditions favouring it, the authors describe concisely some of the more modern methods of mango propagation, culture and harvesting. They also briefly discuss here the irregular bearing of mango varieties, a problem of considerable commercial importance. Leading insect pests and diseases of mango and methods of their control where known are discussed in a separate chapter which, however, suffers from certain deficiencies inherent in the condensed treatment of a rather specialised and complex subject. Certain diseases, for example, mango malformation and black-tip are not satisfactorily dealt with in regard to their symptoms and etiology and, in fact, some aspects of these need to be modified in the light of more recent research.

The Monograph on the whole is well produced and will be of help as a reference book to mango connossieurs, growers and scientists. It may be hoped that this compilation would also stimulate the production of much-needed technical monographs on other commercial fruits of this country. S. N. D. G.

Advances in Pest Control Research, Vol. I. By R. L. Metcalf, Citrus Experiment Station, University of California, Riverside Calif., U.S.A. (Interscience Publishers, New York and London), 1957. Pp. vii + 514. Price $ 11.00.

Research on pest control has increased so tremendously in recent years in all countries that it has been difficult to keep track of the subject. This book would, therefore, be welcomed by one and all, whether he is a research student, a field worker or a teacher. As a work of reference, it gives the latest position of our knowledge on pesticides and contributors to the volume are every one of them specialists on the particular subject they have dealt with and this has undoubtedly increased the value of the book.

With the advent of modern synthetic pesticides, health hazards in their use have been giving great anxiety to the public in most countries and engaging even the attention of international organisations. It is, therefore, only appropriate that the publication should commence with a treatise on the most important subject, "The control of health hazards associated with the use of pesticides". There can be no better author to review this subject than J. M. Barnes, who made a general survey of health hazards with the use of pesticides in 1952, on behalf of the W.H.O.

Our present knowledge of the chemistry and mode of action of herbicides has been ably dealt with by A. S. Crafts. This author has admitted that there is need for knowing more of the biochemistry and physiology of herbicides. It is hoped that scientists working on them would pay more attention to these lacunæ existing in our information.

The use of organic phosphorus insecticides in insect control has been considerably increased in recent years in spite of their high mammalian toxicity. The fundamental aspects of che-

mistry and action of organic phosphorus insecticides discussed therefore by T. R. Fukuto are of very great value to those who use them and want to have a more precise knowledge of this subject. He has shown that high anti-cholinesterase activity is not an essential prerequisite in these compounds for high insecticidal activity. In synthesising these compounds, it would be useful, therefore, if chemists try and produce those which are more specific to insects and are less dangerous to mammals.

J. G. Horsfall has treated the general subject of mechanisms of fungitoxicity in such a way as to be understood by even laymen. Furthermore, the discussion is interspersed with humorous remarks which makes the review very enlightening.

Control of plant diseases caused by fungi living in soil has always been a difficult problem. J. B. Kendrick, Jr., and G. A. Zentmyer have dealt this subject in all its aspects and summarized our present knowledge of chemical control, physical control, biological control, development of disease resistance as well as the important plant quarantine subject of regulatory control of soil fungi. One cannot expect a better presentation of the matter than what has been attempted by the authors.

The use of Repellents against insects and other Arthropods has gained in importance, particularly during the Second World War and afterwards, and much work has been done during the last few years. That this subject should also receive a place in this review is not surprising. The masterly review on the Repellents for Biting Arthropods by G. F. Shambaugh, R. F. Brown and J. J. Pratt, Jr., cannot but be commended.

The use of systemic organo-phosphorus insecticides has progressed considerably during the last few years in spite of their high toxicity to mammals because it has been shown that with thorough precautionary measures, it is possible to avoid hazards of application. Dr. W. E. Ripper, one of the foremost authorities on systemic insecticides, has given an excellent and critical review of the status of these insecticides in pest control practices. The methods of applying these insecticides, such as, Foliar sprays, bark application, soil treatment as well as trunk implantation and seed treatment and their relative importance have been exhaustively dealt with by him. The author has concluded his review with a brief account of selectivity of the systemic insecticides and the integration of biological and chemical methods of control. More work on this subject is necessary, and as the author himself states, a much greater effort to find more selective systemic insecticides is warranted.

The increased use of pesticides in recent years has brought in its wake problems relating to their residues. M. S. Schechter and I. Hornstein's review of "Chemical Analysis of Pesticide Residues", and Dr. Yun-Pei Sun's "Methods of Bioassay of Pesticide Residues", are, therefore, of very great use to all dealing with pesticides. The table indicating range of tolerance of residues of insecticides included by the former authors would come in very handy for reference.

To maintain a safety record, besides educating the public in the proper use of pesticides in most advanced countries, Pesticides Acts have been enacted so as to regulate the import, manufacture or sale of pesticides. Schechter and Hornstein, in their introduction to the review on analysis of pesticide residues, have shown the importance of such Acts. The reviewer had an opportunity some years ago to draft a Pesticides Act for this country, but for some reason or the other, it does not seem to have been enacted. With more and more poisonous and new insecticides introduced in the market, particularly in a country like India, there is great need for early legislation to regulate the import, manufacture and sale of pesticides, as well as for setting tolerances for residues of pesticides on various crops. On account of the important problem of pest residues in food, there is also need for legislation as regards their permitted levels. As stated by J. M. Barnes in his review on control of health hazards, this should be simultaneously accompanied by an effective service for analyzing food for pesticide residues.

In conclusion, the editor, Prof. R. L. Metcalf, as well as the Interscience Publishers, Inc., have to be congratulated for publishing this authoritative and most useful book.

V. P. R.

Books Received

Carnegie Institution of Washington Year-Book, 1956-57, No. 56. (Carnegie Institution of Washington, 1530 P St., Northwest Washington 5, D.C.), 1958. Pp. xliii + 425. Price $ 1.50.

Safety Techniques for Radioactive Tracers. By J. C. Boursnell. (Cambridge University Press, London N.W. 1), 1958. Pp. xi + 68. Price 7 *sh.* 6 *d.*

The Sources of Invention. By J. Jewkes, D. Sawers and R. Stillerman. (Macmillan & Co., St. Martin Street, London W.C. 2), 1958. Pp. xv + 428. Price 31 *sh.* 6 *d.*

SCIENCE NOTES AND NEWS

Synthetic Diamonds

In a preliminary statement (a letter to *Nature*, 1958, 181, 758), Prof. Lonsdale and Dr. Grenville-Wells report that 10 representative specimens selected by them have been studied to date. In every case these laboratory-made diamonds showed one outstanding diffraction feature, namely, the presence of a comparatively strong (200) reflexion, which is never shown by any natural diamond, whether of terrestrial or meteorite origin. Other 'forbidden' reflexions were also present.

Prof. Lonsdale and her co-worker say that the apparent explanation is that each diamond consists of a matrix of a normal diamond with the carbon atoms in their usual positions and spacings, but that within this matrix there are islands of a different structure with a lattice constant or spacing close to that of diamond but different from it.

Spectroscopic analysis of the diamonds carried out by Johnson Matthey's research laboratories has demonstrated the presence of some 0·2% of nickel. The presence of the nickel 'points to a probable explanation of the subsidiary structure' for, nickel does not normally appear as an impurity in natural diamonds. The closeness of its lattice constant to that of diamond indicates that it might be a possible inducer of crystallization of carbon in the diamond form. It is suggested that the process of cooling from high temperatures and simultaneously expanding it from high pressures, could well leave islands of face-centred cubic nickel of Ni_2C or some other nickel compound in a state of strain.

New Oestrogenic Hormone Isolated from Clover

A New Oestrogen—a type of hormone regulating specific growth activities—has been isolated from Ladino clover and its structure has been determined by scientists of the U.S. Department of Agriculture. This potentially valuable œstrogen—named coumœstrol—is also present in lucerne and strawberry clover.

Research workers at the USDA's Western Utilisation Research and Development Division, Albany, California, report that coumœstrol is different in chemical structure from other known animal and plant œstrogens. Although œstrogenic compounds are known to be active in about 40 plants, only a handful of these hormones have been isolated.

Coumœstrol, a crystalline substance, about 30 times more active than genistein, is one of the most potent œstrogens in forage crops. It is less powerful in its effects on animals than stilbœstrol.

Oestrogenic activity interfered dramatically with normal fertility among sheeps in Western Australia during the 1940's. Cause of this decline in fertility was at first not understood, but was later traced to excess intake of clover œstrogen. This was due to war-time shortages of fertilisers and bulk feeds, and scanty rainfall, causing a greater than normal consumption of clover for a long period of the time in that country.

Plant œstrogens are just beginning to be studied systematically. Recent work at Indiana, U.S. Agricultural Experiment Station, has shown wide variations in œstrogen concentrations in lucerne during the growing season. Work also showed lucerne leaves have more œstrogen than the flowers and flowers more than the stem. Lucerne silage made with blackstrap molasses contains more œstrogen than lucerne in pasture or lucerne ensiled without the molasses.

A Third Atomic Reactor for India

India's third atomic reactor is expected to go into operation during 1958-59. Known as "Zerlina" it will assist scientists and engineers doing research work on new designs for atomic reactors.

The first Indian reactor, "Apsara", started functioning in 1956. It is being used for research in neutron physics and production of isotopes. A second reactor, which will probably be in operation by the end of this year, is being set up in co-operation with the Canadian Government under the Colombo Plan. It will enable experiments to be made on the conversion of thorium into fissile uranium.—UNESCO.

Antidote to Strontium

The discovery of a new chemical substance which it is claimed, checks and eliminates the effects of strontium in the human body has been announced at a Meeting of the American Chemical Society in San Francisco.

According to Dr. Arthur Lindenbaum, of the Argonne National Laboratory in Illinois, it is a tasteless yellow dye called rhodizonate. It might lead to the development of a series of chemical compounds which would cleanse human and animal bodies of other radioactive substances. Rhodizonate is said to act by attaching itself to strontium atoms in the body, and forming an insoluble compound, which is eliminated from the system as waste matter.

A Camera that Locates Radioactivity

A camera, able to locate any source of radioactive contamination in areas that are too "hot" for radiation-detection instruments, has been developed in the United States. This pinhole camera, which is about the shape and size of an ordinary box camera, is made of lead and uranium, and weights 29 lb. It has a uranium lens barrel and a 0·0135" pinhole and makes both conventional and X-ray pictures.

Aimed toward the contaminated area, the camera simultaneously takes a picture on conventional film and records radiation on X-ray film. When the X-ray film is superimposed on the conventional film, the source of radiation is quickly pin-pointed.

The photographic record is made in minutes —a task requiring days of painstaking work, with even the most effective radiation detection instruments. The camera, now in use at the Knolls Atomic Power Laboratory, Schenectady, New York, was designed by an engineer, at the General Electric Company.

Rocket Lifts One-and-a-half Ton 'Laboratory' Nearly Three Hundred Miles

On February 21, a single-stage geophysical rocket was launched under the I.G.Y. programme from the middle latitudes of the European part of the U.S.S.R. The rocket reached a record height of 473 kilometres. It was equipped with geophysical instruments for complex investigation of the upper layers of the atmosphere. The total weight of the geophysical scientific instruments, radio-telemetering devices, power sources and auxiliary systems, together with the instrument container which went up with the rocket, was 1,520 kg. (about 3,345 lb., or nearly 1½ tons).

The following geophysical instruments were installed in the rocket:

(1) An ultra-short wave dispersion radio interferometer for measuring free electron concentration in the ionosphere; (2) An instrument to measure the ionic composition of the atmosphere; (3) Instruments for measuring the concentration of positive ions in the atmosphere; (4) Ionisation and magnetic gauges for measuring atmospheric pressure; (5) An instrument for measuring electronic temperature; (6) Instruments for recording collisions with micrometeoric particles; (7) A solar spectrograph for recording the ultra-violet region of the spectrum.

The use of rockets which take up instruments into the ionosphere allows for new research methods which are inaccessible to research workers, based on earth. Studies between 200 and 250 kilometres have materially altered our conceptions of the structure of the ionosphere at these heights.

New Economic Process for Separation of Uranium, Thorium and Rare Earths

Uranium, thorium and rare earths in high yields and high purity are claimed to be obtained using a process developed at Ames Laboratory, Iowa State College, U.S. According to a report given to the 133rd ACS National Meeting held recently, almost all thorium present in monazite ores, together with about 98% of the cerium and about 90% of uranium is separated. Thorium is stated to have no uranium in it; the uranium is free of cationic impurities; and cerium is separated from the other rare earths.

An outline of the process is as follows: The monazite ore is concentrated and crushed to particles finer than 65 mesh. This crushed ore is then digested in 93% sulphuric acid at 210° C. for 4 hrs. It is then diluted with water, part decanted and the sludge and undigested sand filtered off. The digested material is diluted still further, adjusted to pH 1·5 and rare earths and thorium are precipitated with sodium oxalate. The uranium remains in solution and is recovered using a strongly basic anion exchange resin. The oxalate cake is taken up in hot caustic, freeing the oxalate for recycle and converting rare earths and thorium to their hydroxides. As 95% of the oxalate is recycled, the process should prove an economic one.

The hydroxides are calcined to remove residual oxalate and to oxidise cerium to the +4 state, and then dissolved in nitric acid from which cerium and thorium are extracted with tributyl phosphate. The cerium is then reduced with sodium nitrite, and cerous cerium goes into the stripping solution. Thorium is removed from the tributyl phosphate by a water strip and the thorium precipitated with oxalic acid.

Symposium on Vegetable Oils and Their Products

A Symposium on Vegetable Oils and Their Products will be held under the auspices of the National Institute of Sciences of India in October 1958, in New Delhi. The scope of the Symposium will be as follows: (1) (*a*) Importance of vegetable oils in Indian economy, (*b*) General survey on the occurrence, production, distribution and consumption of vegetable oils. (2) Applications of edible as well as non-edible oils. (3) Scope for newer and better utilization of non-edible oils and their products. (4) Improvement in production methods: milling, solvent extraction, refining, bleaching, hydrogenation, etc. (5) Physiology and biochemistry: Fat in nutrition, absorption, metabolism. (6) Chemistry of fats and oils, (7) Testing and analysis of oils and oil products. (8) Equipments, and mechanical devices.

Those desirous of participating in the Symposium may send their papers along with abstracts of about 200 words to the Convener, Dr. U. P. Basu, Bengal Immunity Research Institute, 39, Lower Circular Road, Calcutta-16, so as to reach him by July 31st 1958.

Astronomers' Congress

The Tenth Congress of the International Astronomical Union will be held in Moscow this August. One symposium will discuss the rotation of the earth and the atomic standards of time; another the results of research work on the connection between luminosity and surface temperature in stars.

Second Geneva Conference on Peaceful Uses of Atomic Energy

The Second International Conference on the Peaceful Uses of Atomic Energy is to be held in Geneva during September 1-13, 1958, under the auspices of the United Nations. The President of the Conference is to be Prof. F. Perrin, of the Commissariat a l'Energie Atomique de France, and the Secretary-General, Dr. S. Eklund, of Sweden. Two atomic energy exhibitions will be held in Geneva during the Conference. The first will be a scientific exhibition under the auspices of the United Nations, at the Palais des Nations. The other exhibition, which will be commercial, is the International Exhibition on the Peaceful Uses of Atomic Energy, at the Palais des Expositions.

Conference on High Energy Nuclear Physics

More than 200 scientists from twenty-six nations have been invited to participate in the 1958 Annual International Conference on High Energy Physics, organized by the European Organization for Nuclear Research (CERN), in Geneva during June 30-July 5. Participation at the 1958 Conference is by invitation only. During ten plenary sessions in the auditorium of the Physics Institute of the University of Geneva, papers will be presented on nucleon structure; the nucleon and its interactions with pions, photons, nucleons and anti-nucleons; fundamental theoretical ideas; strange particle production and interaction; invaraince principles and selection rules, and weak interactions. The Conference Proceedings, including original papers presented, will be published by CERN.

Lady Tata Memorial Trust Scholarships and Grants for the Year 1958-59

The Trustees of the Lady Tata Memorial Trust announce on the death anniversary of Lady Meherbai Dorabji Tata, 18th June 1958, the awards of scholarships and grants for the year 1958-59.

International awards of varying amounts (totalling £ 5,080) for research in diseases of the blood with special reference to Leucæmias are made to Doctors M. Seligmann (France), M. Simonsen (Denmark), A. J. Therkelsen (Denmark), B. G. Thorell (Sweden), M. Bessis (France), G. Klein (Sweden), Mr. A. Pillai (Switzerland), Dr. J. Ponten (Sweden).

Indian Scholarships of Rs. 250 per month each for one year for scientific investigations having a bearing on the alleviation of human suffering from disease are awarded to: Dr. (Miss) Habib Bano (Lucknow), Dr. (Miss) Satwant Kaur Sokhi (Madras), Miss M. H. Gandhi (Bombay), Mr. P. Suryanarayana Murthy (Bangalore), Dr. Inder Perkash (Lucknow), Miss S. Saroja (Bombay) and Mr. N. L. Tikotkar (Bombay).

593-58. Printed at The Bangalore Press, Bangalore City, by C. Vasudeva Rao, Superintendent, and Published by A. V. Telang, M.A., for the Current Science Association, Bangalore.

All material intended for publication and books for review should be addressed to the Editor, *Current Science*, Raman Research Institute, Bangalore-6.

Business correspondence, remittances, subscriptions, advertisements, exchange journals, etc., should be addressed to the Manager, Current Science Association, Raman Research Institute, Bangalore-6.

ANNUAL SUBSCRIPTION

India: Rs. 8-00. Foreign: £ 0-16-0. $ 2.50.

uction

weep

easy

sharp

accu-

RT.

curate

era.

libra-

ds.

new

your

u can

t you

y the

D.

LHI